16th ICCRTS: Collective C2 in Multinational Civil-Military Operations

Paper 007: Meeting capability goals through effective modelling and experimentation of C4ISTAR options

Authors

R J Barton
Managing Director
Niteworks
Brennan House
Farnborough Aerospace Centre
Hampshire GU14 6YU
UK

R P Whittington
Chief Strategy Officer
The Salamander Organization Ltd
University Science Park

York YO10 5ZF
UK

Point of Contact

Jessie-May Brown, Communications Manager, Niteworks;
Email: jessie-may.brown@niteworks.net Tel: +44 (0)1252 385405

Abstract

Over the past year, Niteworks - a UK MOD owned collaborative venture with Industry - has undertaken a variety of capability based analyses for improving decision support and operational capability of C4ISTAR. These have used a number of emerging techniques which are being developed into an overall methodology to ensure a more cohesive and data-rich, evidence-based approach to capability investigation and management. The techniques have been used to support multi-national experiments and collaborative environments and the aim is now to embed these as common practice.

The approach adopted throughout is driven by explicit definition of capability goals, and addresses the need to make cost-effective decisions at various levels, consistent with achievement of these. The techniques deployed include development of architectural models that envelop and control complex webs of inter-relationships across the elements that need to be marshalled to meet these capability goals. These models have been exploited through intuitive visualisations in a controlled and interactive environment, enabling stakeholder communities to understand and explore options, guiding decision effectiveness.

The paper will give examples of how the methods have been applied collaboratively and will seek to demonstrate the resulting impact on balancing short term operational needs with long term capability development.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
JUN 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Meeting capability goals through effective modelling and experimentation of C4ISTAR options	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Niteworks,Brennan House,Farnborough Aerospace Centre,Hampshire GU14 6YU,UK**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Presented at the 16th International Command and Control Research and Technology Symposium (ICCRTS 2011), Qu?c City, Qu?c, Canada, June 21-23, 2011. U.S. Government or Federal Rights License.

14. ABSTRACT
Over the past year, Niteworks - a UK MOD owned collaborative venture with Industry - has undertaken a variety of capability based analyses for improving decision support and operational capability of C4ISTAR. These have used a number of emerging techniques which are being developed into an overall methodology to ensure a more cohesive and data-rich, evidence-based approach to capability investigation and management. The techniques have been used to support multi-national experiments and collaborative environments and the aim is now to embed these as common practice. The approach adopted throughout is driven by explicit definition of capability goals, and addresses the need to make cost-effective decisions at various levels, consistent with achievement of these. The techniques deployed include development of architectural models that envelop and control complex webs of inter-relationships across the elements that need to be marshalled to meet these capability goals. These models have been exploited through intuitive visualisations in a controlled and interactive environment, enabling stakeholder communities to understand and explore options, guiding decision effectiveness. The paper will give examples of how the methods have been applied collaboratively and will seek to demonstrate the resulting impact on balancing short term operational needs with long term capability development.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**56**	

Introduction

The impact of individual and sharply-bound Military Service lines within the UK has led to a legacy of C4ISTAR (US C4ISR) solutions which operate within relatively constrained specifications (see for example [1]). As a consequence, solutions have evolved piecemeal, and whilst fulfilling specific focused needs, contribute to a deployed capability that suffers from both duplication and, more importantly, shortcomings when tested in the broader, cross-domain role, and in the context of collaborative environments. Furthermore, there is significant political pressure both to streamline the capability acquisition process and to reduce cost [2, 3, 4, 5, 6].

The key to achieving this broader need for coherence and agility, within the constraints of the current political and economic climate, is a strong experimental base that enables identification, exploration and validation of options. Fundamentally, this implies the need for an ability to understand and manage the "trades" that are available, as any decision to invest in one capability must be at the expense of others. Such an approach, however, cannot begin with a "green field", and the current challenges are compounded by the high number of differing providers of previous and often bespoke solutions. These extant and fielded systems dictate that future experiments must begin with a representation of today's network and status quo, and must be underpinned by high levels of cooperation between the providers.

Niteworks [7] is a unique MOD / Industry collaboration, designed to bring together the right people and organisations from across the breadth of UK Defence, in the interests of delivering rapid experimentation to foster better mutual decisions on the way forward. In any situation where the degrees of freedom are substantive and the option potential is broad, it is imperative to find a means of making realistic trades between possibilities and determining the best fit across time, performance and cost: often referred to as optimising 'Value for Money' (VfM) . The acquisition of military capability is a particularly complex process which requires complex trades at multiple levels, often comparing diverse properties, where value for money is intrinsically difficult to measure: consequently, the methods of evaluation must be repeatable and capable of standing up to public scrutiny.

This paper describes how a sample of the experiments conducted by Niteworks over the last two years have contributed to the National and International development of more joined-up solutions and in so doing have led to the development of methods and techniques which can be used more widely to improve solution acquisition, particularly in C4ISTAR. We first elaborate on the Niteworks approach, and especially the trading environment that has been developed.

The Need for Trading and the Capability Value Chain

Balanced and well informed trades are a fundamental part of exploring the problem-solution space and establishing an optimised balance of investment. Such trades must be undertaken inside an architecturally sound environment where information is integral. The key aspect from the scrutiny perspective is to ensure that traceability of Value for Money is clear. Trades need to be conducted at all stages of the process and Figure 1 summarises the trade space opportunity in terms of a 'capability value chain'.

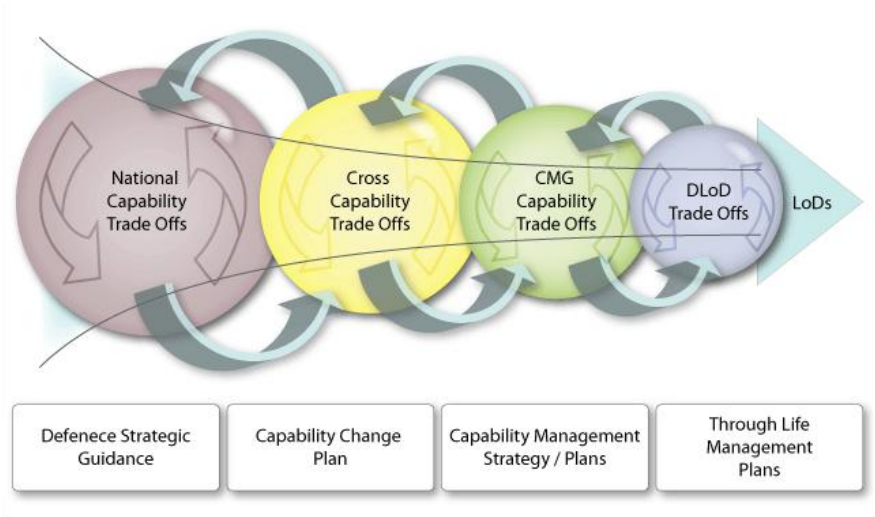


Figure 1. The Capability Value Chain

The MOD's Capability Value Chain [8] emphasises the areas and opportunities for essential

trade-space work to be accomplished. The intersection of each of the defined areas is an opportunity to balance requirements and concept solutions. The flow from left to right represents aspirations and budget, whilst the returning right to left flow is the solution and cost feedback. Without appropriate techniques to value and debate the conflicts in those views, system balance is unachievable and the delivery of required capability unlikely. Conversely the likelihood of cost growth increases.

Capability, Trading and the Niteworks Approach

Commercial Context

Niteworks was established by UK MOD in July 2003 to examine the challenges of implementing effective Network Enabled Capability (NEC). Since then it has evolved from its background in traditional warfighting experimentation into a broader, more flexible decision support scope that enables early and effective industrial collaboration and engagement. The aim is to provide impartial recommendations to enable UK MOD to make better, faster and more informed decisions to enhance current and future military capability. [7]

Early collaboration has long been argued for as the potential answer to both improving MOD/Industry relations and getting a better view of, and approach to, VfM. In practice though relatively low levels of collaboration have been achieved; Niteworks has demonstrated that this need not be the accepted norm.

Whilst by definition there exists a constant pressure – and rightly so – to deliver VfM from the acquisition process, the default mechanism for achieving this has for some time been competition. In the Defence sector, there has always been a steady mix of new (usually smaller) entrant companies but over the last three decades there has also been huge consolidation resulting in the emergence of a number of effective monopolies. The UK Defence marketplace has become too small and the major equipment 'replacement' cycles too long to sustain indigenous competition. This in turn has reduced the ability for MOD to hold effective competition on an enduring basis[6]. In a number of areas of the Defence marketplace a situation now exists which, to all intents and purposes, is a monopsony (the MOD) facing up to a monopoly (a single Industry provider). This relationship is fraught with difficulties, with both sides finding it challenging to satisfy the twin goals of VfM (MOD) and shareholder value (Industry).

Collaboration therefore has an important role in balancing the monopoly/monopolistic tendencies. It is important to draw a clear distinction between partnering and collaboration. There is undoubtedly a logic for better partnering in the long-duration, long cycle-time major equipment areas such as missiles, ships, helicopters, submarines and munitions: this recognises that there are dominant Primes in these areas. But where there is a more diverse industrial base the approach should be more collaborative.

MOD-Industry Collaboration

Within a collaborative environment, issues can be resolved through a data rich, evidenced dialogue around affordability, where parameters such as need, appropriateness and cost effectiveness of solution can be debated. Effectively a "trade space" can be established that is more effective for all parties than the rigorous process of specification and offer which characterises a compliant bid process. Within a collaborative environment where trading becomes essential to both sides, levels of openness and honesty are often significantly improved- leading to a far better and earlier treatment of risks and opportunities.

In practice, collaboration is much harder than is immediately obvious. It is inhibited by deeply ingrained assumptions which have been shaped by decades of weak collaborative practice and a "winner takes all" approach.

EU competition law has enshrined the need to employ appropriate competition in procurements. Whilst the defence area has to comply with European Union (EU) articles, there is very little recognition within EU law of the unique circumstances which constitute the Defence environment. Clearly, in a near monopsony/monopoly situation, the simplistic application of competition is not appropriate. Too often, however, competition is used as a default rather than entering into a process of consultation or collaboration (see [9] for further analysis of this issue).

If the difficulties of collaboration make the initial arrangements problematic, then the spectre of IPR compounds it significantly. Worse still, their continuation becomes ever more challenging as the sustaining mechanism requires constant "feeding" in the form of energy, effort and financial support- which can often be missing.

Role of Niteworks

The Niteworks partnership has overcome these issues in a sustained way. Niteworks was originally established on a ticket to bring together the capabilities that Industry and MOD can collectively offer to the experimentation 'party'. But is it possible to make this work across broader areas of Defence?

Contracting for specific solutions requires a taut arrangement, although even within such a set-up there needs to be a much greater recognition of the inevitable changes and problems which emerge as a contract is fulfilled. It is impossible to foresee all the problems and to realistically plan to a low level of detail for the full programme at the outset, but this is sadly the situation prescribed (or expected) by both contracting parties. Consequently, the necessity of flexibility or ability to trade – as a two-way process – is often unachieved in one-to-one relationships.

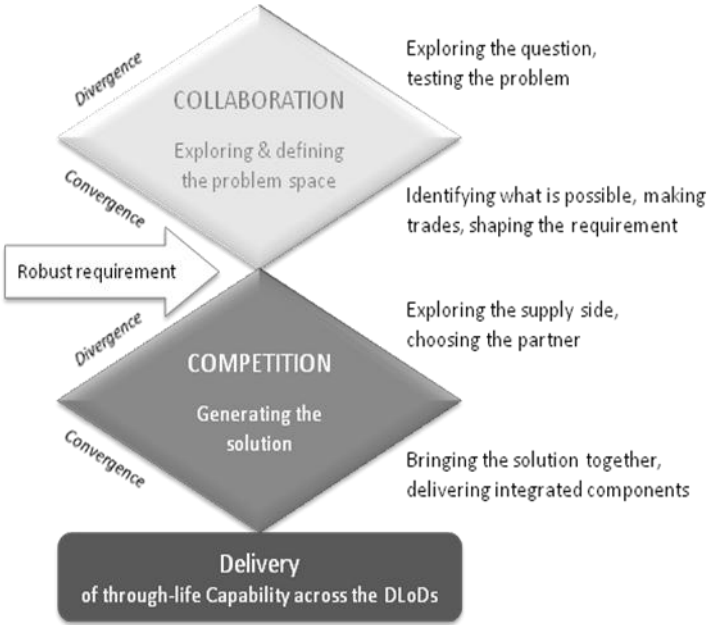


Figure 2. Niteworks Methodology

In 'one-to-many' collaborative arrangements, the protection of background Intellectual Property is a critical consideration for all suppliers. Clearly for the industrial players, IPR represents their "crown jewels"; it is the primary means of establishing their competitive position and consequently something which they will be in no position to give up lightly. However, the misplaced treatment of IPR can be an inhibitor to developing relationships. Historically, poor IPR behaviour on both sides of the MOD/Industry divide has adversely impacted the potential for collaborative arrangements. For example, MOD would argue that Industry can be "over-protective" of their IPR; from the other side, there are examples quoted by Industry of competitive early bid responses, involving IPR release, that subsequently find their way into the next "Invitation To Tender" (ITT), destroying any advantage that the IPR owner may have thought they had. Such behaviour is death to any level of disclosure, which ironically can then be viewed by MOD as 'unhelpful'.

Niteworks has developed a model for effective MOD-Industry collaboration across its base of partners and associates, based on experience in many MOD projects over the last eight years. In carrying these out, Niteworks has developed ways of working which have been tested via practical exemplars, captured in Figure 2.

The key aspects of the model are the two divergent-convergent phases, only one of which (the upper) is regarded as the "collaborative region". It is vital to maintain the "air gap" between the two as this is the region where the competitive arrangements are formed. The lower diamond can, of course, be done collaboratively, but is subject to EU competitive legislation and any opportunity here must be under specific commercial arrangements.

In sum, it is clear that there is a spectrum of opportunity over which the collaborative model can be made to work. In order to achieve this, it is critical that all parties recognise the value of collaboration (especially in the sectors where there are many companies playing, such as C4ISTAR).

An Information Environment for Trading

To support this approach, an environment (see Figure 3) has been developed to address the challenges of collaborative, timely, multi-levelled, evidenced decision support, and which recognises the importance of information management and of providing compelling visualisation.

The environment has been designed to operate in a situation where data is distributed and incoherent, and where there is a need for strong visualisation of the wider picture, in a form amenable to a range of stakeholders. This will enable identification and analysis of trading options end-to-end across the capability management arena. It also acknowledges the pragmatic reality of disparate and incoherent data through a synchronisation mechanism that constructs a coherent unifying architecture of the landscape. This can be automatically refreshed from external sources, and it is capable of generating and supporting trading options across the portfolio.

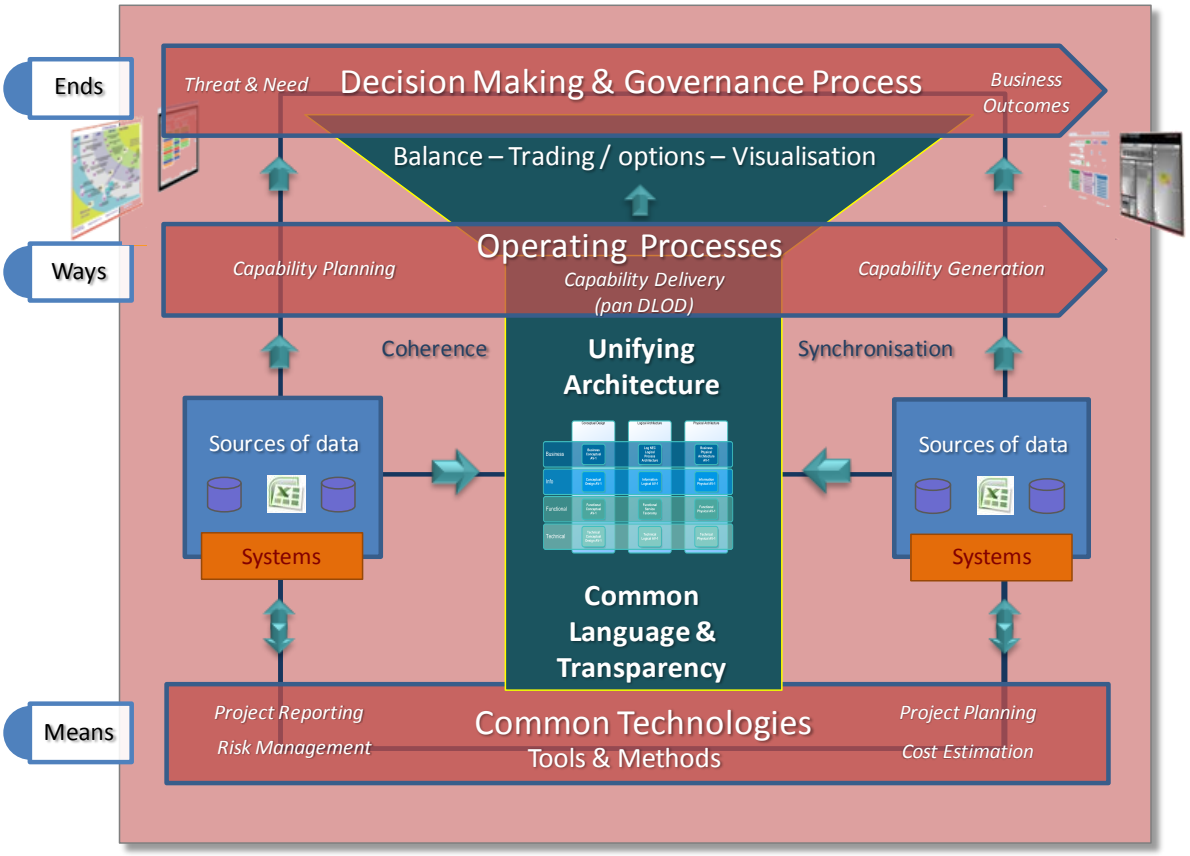


Figure 3. Environment for Capability Trading

The environment is aligned with the MOD's strategy for Enterprise Architecture [10] and policy for information coherence [11], and is underpinned by MODAF[1] [12] to provide a robust methodology which draws together a proven collection of models, processes, tools and techniques. It enables tools and techniques to be applied within a managed, consistent decision-making process. It provides a single point of access for visualising well structured, coherent, static and dynamic data sets, making use of a wide range of visualisation styles and metaphors including targets, graphs, dials, and charts of various kinds. At the heart of the environment is an information connection, management and visualisation capability provided by Salamander's MooD® software [13]. MooD has been chosen for this central role as it offers the best available match to the needs of such an environment, and is available and used widely within the MOD and major Defence Industry players. Note that further description of the environment and its early deployment is provided in references [14, 15, 16, 17].

The environment has now been deployed in many situations across MOD to support trading decisions, principally but not exclusively within the acquisition process, and principally but not exclusively in the context

[1] MODAF is the Ministry of Defence Architecture Framework

of C4ISTAR capability. An interesting insight from these experiences has been that the means to support trading decisions in complex situations is essentially similar across all contexts. These needs include the ability to gather, structure, unify (into a common model); to support flexible analysis across the model (of options and scenarios), and to generate a wide range of visual presentation forms that express projected outcomes to relevant stakeholders (e.g. covering capability effectiveness, cost, time, risk …).

Crucially, the use of an environment of this power is not limited to early-stage decisions, but end-to-end, supporting continual evolution of requirement, following the principles of Through Life Capability Management [18].

Case Studies Undertaken by Niteworks

The following series of case studies offers a selection of applications of this environment to MOD challenges, in the context of the current legacy and commercial situation, to illustrate a number of key learning points:

- Collaboration across stakeholders is key. This includes not only military roles – including coalition partners – but also Industry.
- Implications of an option may not be obvious. In a complex domain the full impact of inter-connections may be unknown. Although the environment may not be able accurately to predict such consequences, its extensive and unified model is likely at least to be able to identify contributing factors, and therefore support "deep dives" to explore relevant situations.
- Any approach to option trading must address the full range of Defence Lines of Development (DLoD) [19], because, for example, there may be key trades between equipment sophistication and level of training needed.

With each case study presented, the problem and approach is described. Following a narrative of the project execution the benefits are explained, in each case demonstrating some aspect of the effectiveness of the Niteworks approach to addressing the problem of acquiring and deploying effective military capability.

Case Study 1 - Visualising the future of Army equipment

The AEDP (Army Equipment Development Plan) project was conceived to drive a major step change in understanding and developing a consistent picture of the British Army's equipment priorities and issues, allowing resources to be directed to the most difficult and urgent areas and ensuring frontline soldiers receive the best possible equipment.

In recent years significant efforts have been made to ensure that all parts of the British Army involved in future planning share a common vision of the way forward. With the Strategic Defence and Security Review (SDSR)[2] gathering pace, and the regular round of budget planning on the horizon, the need to represent the broad range of issues and views from across the Army in a single, robust plan became greater than ever before.

A Niteworks team suggested an alternative approach to traditional campaign planning, favouring techniques around capability visualisation and group planning to develop rapid decision support outputs. In the simplest terms, this involved developing a series of scored graphics showing how well the Army are able to achieve, over time, what they have been asked to deliver. The team suggested the use of capability 'bullseye charts' as the visualisation tool, using different colours to indicate the level of capability available at different points in time, dependent on the equipment available. This also demonstrates the effect of changes in budget, costs and organisational structure, for example, on the ability to deliver equipment programmes.

[2] The UK Government published its Strategic Defence and Security Review (SDSR) on 19 October 2010 [4]. This sets out how it will deliver the priorities identified in its National Security Strategy. Entitled *'Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review'* it details how UK Armed Forces will be reshaped to tackle emerging and future threats.

The initial Niteworks *QuickLook*[3] took four weeks, with the team working closely with the British Army to deliver a methodology, suggesting visualisations such as the bullseye[4] to present outputs and undertaking a first run through of what the answers might be. The *QuickLook* was well received, with the bullseye being used to brief the Executive Committee of the Army Board (ECAB) and highlighting equipment issues that needed addressing.

The *QuickLook* was followed by a full three month project, this time using real data to generate real outputs, feeding real ECAB decisions to support the SDSR process and beyond, and underpinning the decisions with a high level cost model. A critical element was the facilitation of a series of military judgement panels bringing together around 150 personnel from all areas of the Army and the joint environment. Niteworks facilitators and Army staff took participants through a process of scoring the bullseye, ensuring it reflected their operational experience as well as analytical evidence already collected. Dstl[5] subsequently undertook a thorough review of all of the data to ensure its robustness.

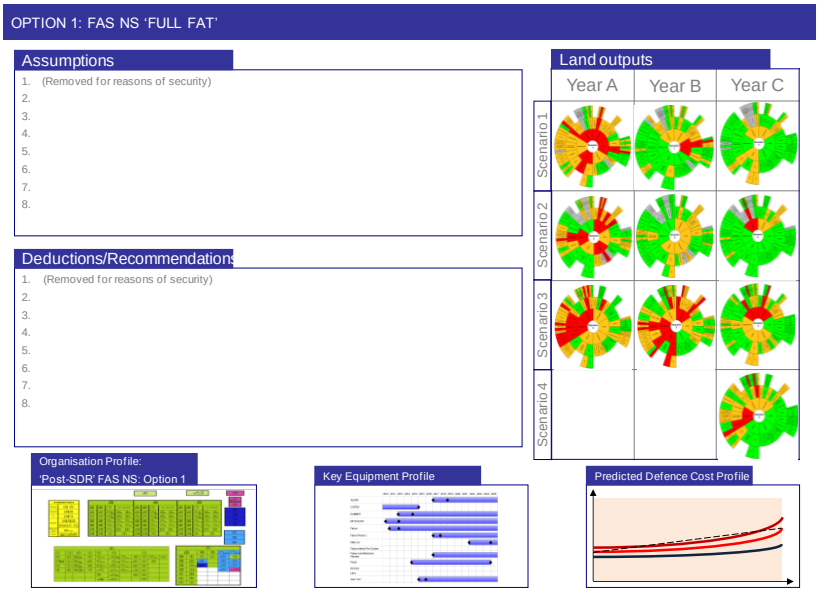


Figure 4. Representative (dummy) AEDP Environment outputs

The Niteworks team applied the trading environment described previously to configure for the sponsor a web based information environment (using Salamander's MooD technology), containing all of the visualisations delivered by the project and the linkages to the underlying data sources. Via a limited access logon this enables MOD personnel to see how well the Army is doing in meeting its equipment objectives, as well as updating and rescoring the picture and adding information.

As a result of the AEDP project, senior Army decision makers now have a way of understanding more easily the relative priorities of difficult, complex equipment issues. Army equipment needs can also be better articulated in the context of Defence-wide, tri-service decision-making and simple, intuitive visualisations can be used to support making the right choices about the future of equipment, within a policy context. The outputs from the project were fed directly into ECAB, supporting many of the rapid revisions leading up to SDSR, and are still in use helping the Land environment to restructure and refocus following budget cuts.

Importantly, the AEDP methodology is both DLOD and Force independent - there is scope therefore for using it across the three Services and more widely across the capability space.[6]

Case Study 2 - Information exploitation - securing a clear view of the battlefield

Recent operations in Iraq and Afghanistan have prompted UK military forces to look for ever more efficient ways of sharing information with their allies. The challenge is clear and urgent: in the heat of the battle,

[3] *QuickLook* is a rapid, short duration examination of the problem and prior work, to baseline the problem space.
[4] The *bullseye* is one of the key visualisation techniques applied by the approach; illustrated to the top-right of Figure 4, bullseyes can be used to indicate projections of capability maturity over time.
[5] Dstl is the MOD's Defence Scientific & Technology Laboratory.
[6] The current deployment of AEDP and its wider potential was presented at "Integrated Enterprise Architecture" in London, March 2011 - http://www.integrated-ea.com/programme

getting the right information, to the right person, at the right time can mean the difference between life and death - staying one step ahead of the enemy and avoiding 'friendly fire' when the fog of war closes in.

This was the context for the Niteworks *Talon Strike* project, which over the past two years has demonstrated solutions to the implementation and acquisition of effective command and control interoperability between coalition partners. With more than 600 UK and US personnel involved in the culminating exercise, including 10 companies and MOD military and civilian staff accessed via the Niteworks Partnership, the project drew on the best talent and expertise from across Defence. The result has been a major shift of the boundaries of command and control: namely, the demonstration of working solutions to complex components that weren't originally designed to work together and the identification of solutions to capability gaps that can drive real improvements for current operations.

FLOIS Study

It was against the background of an increasingly high operational tempo in Afghanistan that the UK Ministry of Defence (MOD) and the US Department of Defense (DoD) initiated the *Future Land Operations Interoperability Study (FLOIS)*. The US Department of the Army and the UK MOD's Head of Capability, Joint Training, Evaluation and Simulation (Cap JTES) sponsored the initiative, with the US Army TRADOC Analysis Center (TRAC) and the UK Defence Science and Technology Laboratory (Dstl) initially conducting the analysis.

The FLOIS Study looked at how staff interact when a UK brigade operates under the command of a US division. Using the setting of a US-based exercise called OMNI FUSION, a representative UK brigade staff operated US equipment whilst examining the inter-staff processes needed to conduct medium scale combat operations on a coalition basis. The analysis of the exchanges demonstrated the scale of the challenge posed by US and UK forces using different systems, technologies and procedures. The next phase of the study would test real equipment in a distributed experiment between the US and UK, using a series of routine exercises as de-risking events.

The initial FLOIS reports highlighted an urgent need to draw on the broadest expertise and technologies from across Defence, from within the MOD as well as across the industrial base, in order to achieve a step-change in command and control capability. The mechanism for achieving this fusion of deep subject matter expertise and latest innovations was Niteworks. With its broad industry membership encompassing the major UK Defence primes, as well as SMEs and academia, Niteworks was ideally placed to assist the MOD in pushing the technological boundaries of UK-US interoperability.

Talon Strike Study

The ensuing Niteworks project which commenced in September 2008 included a team of MOD, Dstl and industry staff using the actual systems that were likely to be deployed on operations between 2010 and 2015. Niteworks organised a major conference in Farnborough, attended by warfighters from the US Army's 101st Airborne Division and the UK's 12 Mechanised Brigade Headquarters. This confirmed the command and control systems to be used during the project, including the culminating exercise, and agreed the focus on shared situational awareness, a common operational picture and a dynamic collaborative planning environment.

An infrastructure was put together in the UK and used at the UK Coalition Warrior Interoperability Demonstration (CWID) and then at the US Exercise OMNI FUSION in 2009. The latter saw troops from 12 UK Mechanised Brigade fly over to the USA to take part, where their responses to a range of scenarios that could be encountered on coalition operations were tested. The exercise was regarded as a key milestone in the project and UK involvement drew particular praise from the US Army. Importantly, the exercise simulated and de-risked the distributed links which would be later installed across the Atlantic for the culminating Exercise TALON STRIKE.

The next priority was to lay down the command and control architecture for Exercise TALON STRIKE. In the UK, Niteworks worked with the Command and Control Development Centre (C2DC) at the Land Warfare Centre to build a Concept Capability Demonstrator. In the USA this task fell to the Battle Command Battle Lab, Leavenworth (BCBL-L) assisted by TRAC. This enabled the development of a suite of systems, based on the

technologies that were due to be used by each nation in the near future but integrated together to facilitate the efficient passage of electronic information.

The project reached a dramatic finale in May 2010, culminating in a two-week long distributed joint exercise involving over 600 UK and US personnel. More than 100 Headquarters staff from 12 UK Mechanised Brigade took part, operating from Warminster, UK; embedded alongside them was the Niteworks team.

The two-week exercise used an Afghanistan-based scenario to explore interoperability issues, identify capability gaps and inform potential solutions or workarounds. Week 1 was set in 2010, with UK Forces using the Joint Automated Deep Ops Coord System (JADOCS) as its primary command and control tool. Week 2 was set in 2017, with UK Forces migrating to BCIP 5.4 / ComBAT to communicate with US Forces. Command and control systems on both sides of the Atlantic were stimulated by OneSAF (One Semi-Automated Force), a US system which simulated combat exchanges down to individual soldier level.

With warfighters separated by 5000 miles and up to seven time zones, Exercise TALON STRIKE represented a huge technological and logistical feat for all participants. The exercise marked the first ever distributed experimentation and training event involving a detailed level of command and control integration jointly undertaken by UK and US Forces- just one of many 'firsts' achieved by the Niteworks Talon Strike project.

The project provided valuable lessons on how practical UK-US command and control system interoperability can be achieved in the Afghanistan theatre of operations, including the preparation and demonstration of application interfaces. By developing systems that allow better visibility of troops, equipment, information and decisions, there is an opportunity for driving real improvements in the way that coalition operations are conducted including, crucially, reducing the risk of blue-on-blue incidents. The experiment also revealed how new technologies and procedures can enable vital combat information to be more readily shared between US and UK forces lower down the chain of command.

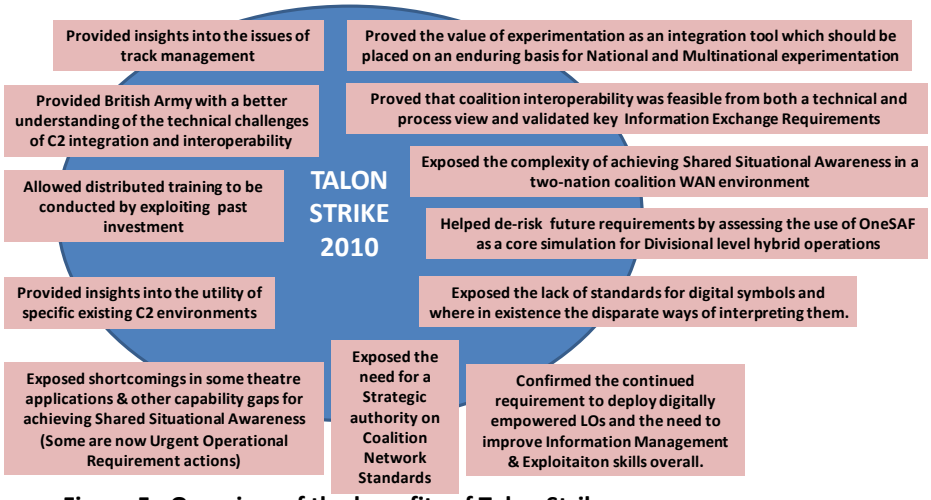


Figure 5. Overview of the benefits of Talon Strike

The project offers strong potential benefits for learning and training: establishing and demonstrating such links enables pre-deployment experience of relevant systems, and how they can be expected to work together. Applying these principles will aid more rapid and effective collaboration between UK and US Forces on operations and allow remote, mission rehearsal exercises to be held in advance of deployments. Furthermore, it has demonstrated the significant value to the MOD of rapid incremental application and system development.

Speaking at the end of Exercise TALON STRIKE, Dr Dai Morris, Head of Capability, Joint Training, Evaluation and Simulation, at the MOD said: "Recent operations in Afghanistan have demonstrated the urgency of seeking ever more efficient ways of sharing information with our allies on the battlefield. Ensuring that we have the right equipment is clearly essential, but it is also vital that we can provide effective training, so that our forces can stay one step ahead of the enemy in an ever-changing environment."

"The Talon Strike project is the largest project ever undertaken by Niteworks and demonstrates the rapid benefits that can be derived for the Armed Forces when the best of Industry, MOD and Dstl are brought together."

Later in the paper we examine how some of the lessons from Talon Strike can be applied to generic frameworks for improving analysis and experimentation.

Case Study 3 - Supporting the development of battle-winning capability

Developing battle winning capability depends on a number of issues, just one element of which is buying the best kit. Test & Evaluation (T&E) for all equipment is also a critical and on-going part of the process- ensuring equipment meets specifications, is fit for purpose and safe for use.

The Niteworks *Test & Evaluation Review* was commissioned by MOD's Head of Capability (Joint Training Evaluation & Simulation) in April 2010. The team was challenged to examine the current cost of T&E in the MOD and review the benefits that could be achieved by transforming the MOD's approach - evidence that would be used to inform the Strategic Defence & Security Review (SDSR).

Previous MOD effort had focussed in the equipment area on the *supply* aspects of providing T&E- e.g. looking at whether MOD was overprovided for internally and by Industry in terms of both facilities and services. The team noted that effort was now also being applied on bearing down on the *demand* for T&E generated by equipment projects, in order to reduce costs. However, it advised that care should be taken to ensure that such focus on reducing cost through reduced T&E did not inadvertently increase the risk to equipment programmes- both through safety issues as recognised in the Haddon-Cave report [19] or through continuing programme delay resulting in cost overruns as highlighted by the Gray Report [2].

The team recommended that MOD, having completed the changes it had previously identified itself, should look again at its commercial procedures for the procurement of T&E. The experiences of the Niteworks team in other public sector environments, such as local authorities, showed that commercial arrangements could be improved; for example, requirements for T&E could be bundled into lots to drive down costs, and contracts with a wide range of long standing suppliers could be retendered to consolidate the number of suppliers and achieve efficiencies of scale. The Niteworks team asserted that significant cost savings could be achieved if these commercial approaches were introduced.

The team's consideration of the potential benefits of transformed T&E clarified that evaluation had a much more critical and broader role to play, concluding that it should be at the heart of capability definition and acquisition reform. The really significant benefits could be realised by transforming the MOD approach to evaluation in the management of enterprise risk by implementing a through life approach to evaluation of military capability. This would need to apply a coherent evaluation, not just to DE&S projects but across Defence as a whole.

The Niteworks team judged that improved T&E could help achieve savings in three different ways: first, through allowing rationalisation of T&E facilities; second, through helping to achieve integrated through life evaluation; and third, by allowing improved management of enterprise risk. The team considered how MOD could better undertake T&E to make this happen.

For this stage of the project, the team looked at good and bad practice- both within the MOD, the broader Defence Industry and in outside comparator industries- through conducting a series of interviews.

The team found that the standards and requirements against which you test are a major cost driver, through both volume of activity required and time taken. Both within Defence and outside, the team established that the volume of requirements tends to increase every time a piece of equipment or capability is replaced or supplemented- with potentially adverse effects on cost and programme duration and with little obvious benefit.

The industries consulted included London Underground, which had carried out a full review of the standards being applied to an upgrade of its lines. This review allowed it to scrap a significant proportion of the requirements for the programme, in turn reducing the need to specify, design and test against them. This resulted in an impressive 20% saving in its programme costs. Interviews with London Underground also highlighted the benefits that can be achieved when T&E is fully integrated throughout the life of a capability. The organisation developed a fully integrated evaluation team, embedding its T&E staff in the sub-contractor

development team for the Victoria line upgrade. The approach reduced the development costs of the programme by 30%.

A final consideration was the significance of T&E in relation to the risk of project overruns, a crucial aspect of Bernard Gray's review of Defence acquisition [2]. Gray's report had found that the largest factor driving project cost overrun was timescale (overruns). Most of that was caused by technical factors- exactly the problems that T&E should help to identify and mitigate. With the average delay of MOD projects running at 16 months, with an associated cost of this lying between £920M and £2.1 billion, these cost overruns represent unfunded enterprise risk; therefore the Niteworks team concluded that improved T&E through integrated through life evaluation with timely assessments offered potential for cost avoidance as well as cost saving. Looking at best practice in MOD and comparator organisations, the team estimated scope for significant savings.

In sum, the *Test & Evaluation Review* found significant benefits can be gained by recognising evaluation as a much more important enterprise risk management tool for the MOD as a whole- transforming its approach to T&E and achieving potential savings across the defence budget. This requires evaluation to be carried out at the right time and place, and managed at a capability rather than individual programme level.

Case Study 4 - Helping to define the future shape and requirements of the British Army

The world is an increasingly uncertain place, characterised by new and more complex threats than ever before in our history. The Armed Forces must be ready to deal with the conflicts they give rise to, both now and in the future.

Recognising the increasingly diverse and complex nature of these conflicts, the British Army established the AGILE WARRIOR initiative in 2010 to help define its future force development, including its structure and capability requirements. The exercise would consist of an annual programme of events and techniques, such as historical analysis, expert judgement panels, simulation, experimentation and training exercises, to gather robust and authoritative evidence to inform this force development.

Led by Land's Force Development and Training headquarters (FDT), the initiative was broken down into seven work packages addressing questions and issues that must be explored in order to drive Army transformation. This included, for example: testing current doctrine and evaluating how it should evolve over the next 10 years; testing how a Multi Role Brigade will fight and operate in a hybrid conflict; also determining the Army's future command and control (C2) requirements for ISTAR and CIS (Communications and Information Systems).

Niteworks involvement included providing direct and immediate support to AGILE WARRIOR 2011 activities, together with capturing lessons to improve future exercises and to put important learning points on an enduring footing.

In terms of providing direct support, Niteworks assisted in three fundamental ways. First, working closely with Dstl, past and present projects were reviewed to identify relevant material that could be exploited by the seven work packages. Niteworks then supplied industry subject matter experts to liaise with work package leads and provide further explanation and advice on these projects. Finally, once work packages had reached a fairly mature state, Niteworks reviewed their emerging outcomes from an impartial industry perspective and provided consolidated feedback.

Niteworks acted as a 'one-stop-shop' for industry engagement at the working level in AGILE WARRIOR, providing a consolidated industry voice at planning meetings, and an 'industry portal' for the experiment. A joint MOD / Dstl industry workshop in March 2011 allowed FDT to expose and test the findings of one of the work packages with a broad and well informed industry audience.

The completed work packages from AGILE WARRIOR 2011 were drawn together and presented at the Army Development Forum, a two-day annual meeting of very senior officers including members of the Executive Committee of the Army Board (ECAB). This ensured that key decisions about the Army's transformation could be made in an informed and evidence-based way.

Niteworks' final task was to help ensure that the process of gathering evidence to inform decisions on the Army's future force structure was put on a regular 'institutionalised' footing- including Industry's involvement in that process. Essentially, this involved learning lessons from AGILE WARRIOR 2011, capturing industry best practice in evidence gathering, and feeding it into the planning process for AGILE WARRIOR 2012. This advice was consolidated in a report delivered to FDT in late spring 2011.

The AGILE WARRIOR project demonstrates the benefit to the MOD of being able to easily access a broad spectrum of industry expertise to obtain impartial and informed advice. It has allowed important decisions to be informed by more robust and accessible evidence than ever before. Niteworks' rigorous facilitation of joint MOD-industry workshops provided an open and impartial forum in which information could be exchanged, avoiding duplication and ensuring engagement with the breadth of Industry.

Case Study 5 - Direct, Process and Disseminate (DPD)

ISTAR[7] is a key capability that generates and delivers intelligence to military personnel engaged on operations. It involves the collection, analysis and dissemination of a range of information from, for example, maritime, land, air and space-based platforms and deployed personnel. This is the innovative technology that enables the Armed Forces to fight smarter wars- however it is highly complex to design and manage.

Whilst investing in intelligence collecting capabilities such as air platforms and deployed personnel is a crucial aspect of effective ISTAR, also important is ensuring that assets are steered to fulfil military commanders' intent in the most efficient and effective way possible. It is in this area that the Niteworks *Direct, Process and Disseminate (DPD)* project has been focussing its attention.

Over the last few decades the equipment and methods for DPD have evolved along single Service lines and this has resulted in areas of duplication, overlap and a less than ideal use of assets. This, alongside the use of different acquisition approaches, has hindered the development of coherence across battlefield capabilities.

The DPD project, which was commissioned by the UK MOD in March 2010, was undertaken to properly understand the impact on military users of such duplication and overlap, and at the same time improve the process through which new equipment and methods are evaluated and subsequently introduced. Niteworks began by undertaking a short *QuickLook* project to examine MOD's current and proposed projects in the DPD space, set against national and multinational policies. The aim was to provide evidence over time of gaps and overlaps in proposed capabilities; this may sound straightforward but in practice it demanded a detailed knowledge of the projects in question and the ability to interpret swathes of doctrine and strategy. The result was a comprehensive survey of the situation and clear evidence that gaps and overlaps did indeed exist. This provided the foundations for a full DPD Capability Investigation in summer 2010.

The Capability Investigation was underpinned by a number of principles, namely: that no new structures should be invented (in other words, that existing methodologies for managing capabilities, through life, should be used); that architectural and modelling work should be sufficient to facilitate visualisation of the problem and proposed approaches and not become an end in itself; finally, that all of this should be done in conjunction with experienced military practitioners. Niteworks held regular briefings to keep its industry members up to speed with developments and held workshops in order to get industrial input into activities.

Work reached a natural conclusion in autumn 2010, when the approaches developed were tested in anger in the run up to the Strategic Defence & Security Review, Comprehensive Spending Review and the MOD's annual account-balancing 'Planning Round' exercise. The results were encouraging and it became apparent that such an embedded approach, backed by appropriate tools and methodologies, could be applied to other complex portfolio programmes.

The DPD work strand has now reached Phase 3, where Niteworks support is concentrating on refining and embedding the work done so far. In parallel with this and in support of it, work is being undertaken to 'industrialise' the processes and approach developed for potential use in other areas of capability delivery.

[7] Intelligence, Surveillance, Target Acquisition and Reconnaissance

The family of DPD has demonstrated how the MOD can reap benefits from the expertise of a mixed industry team, which can be quickly reconfigured as a project progresses through phases that demand different skill sets...and all of this whilst continuing to develop mechanisms that make even the most complicated problems understandable. Work continues and the MOD must now consider to what extent future activities like these form part of normal business. As a result of this work the MOD will be able to make more informed judgements about ISTAR programme choices and our soldiers, sailors and airmen can look forward to the delivery of more timely and effective intelligence.

Extracting long term value - better solution development

In the course of undertaking the above projects a number of techniques have been evolved and tested which have the potential to yield improved specification, trade off and acquisition methods. A recent study by Niteworks was tasked with bringing these ideas together to enable a more consistent and coherent approach to the definition and acquisition of capability. The aim was to identify best practice and deliver a clear architectural approach which brings together the tools and methods into a framework where the wider impacts of options and decisions can be more easily judged.

We have seen that UK Defence is struggling with a series of frustrating organisational, system and technology problems as a result of the stove-piped approach to equipment acquisition. Challenges in delivering coherent programmes that satisfy a clear set of requirements are evident across the enterprise. In addition, limited responsiveness to the pace of technology development has led to projects being cancelled or re-focused too late, costing millions.

Various organisations contribute to the delivery of capability to the front line however there are considerable challenges associated with delivery of the right capability to the right person at the right time. How to harness the technology refresh cycle and exploit innovative technologies and acquisition approaches has to be considered if the best value for defence is to be achieved.

This paper will now discuss the challenges faced by the MOD enterprise through the following steps: consideration of the problem and how it should be represented; how we should tackle the solution using systems engineering principles; where modelling and simulation should be applied; and finally the benefit to acquisition that can be achieved, citing some relevant recent activities.

Visualising the problem

An important first step in being able to develop solutions to the multifarious problems within the 'defence enterprise' is an understanding of how the enterprise works – specifically in terms of its key parts and their interactions or interdependencies. This is a classic application of systems thinking to the enterprise – in other words, considering the defence enterprise as a *system*. A number of techniques exist to develop system partitions that group together clusters of parts that have tight coupling within the system (e.g. N2 diagrams) but these are difficult to apply to a system as diverse and large as UK Defence.

However, applying the principles of such methods, we have been able to identify a set of loosely bound foci that represent key 'areas of concern' within the enterprise, as shown in Figure 6[8]. This partitioning is based on an informal clustering related to the coarse characteristics of each area, including skills involved in each of the areas and existing organisational boundaries. Although this is not a rigorous enterprise model it has utility in appreciating the applicability of different tools and methods, as set out in later parts of this paper.

We also note that the areas of concern are relatively loosely coupled – but there are nonetheless interactions between the areas. In fact, we find that there are multiple interdependencies between the areas of concern, such that many routine enterprise activities require coordination across the boundaries; in many cases this coordination does not take place and this is the root cause of incoherence across the enterprise. From the perspective of enterprise design, effective processes and decision making requires loose coupling between parts but a high degree of coherence.

[8] The reference to TTPs in the Figure refers to "Tactics, Techniques and Procedures"

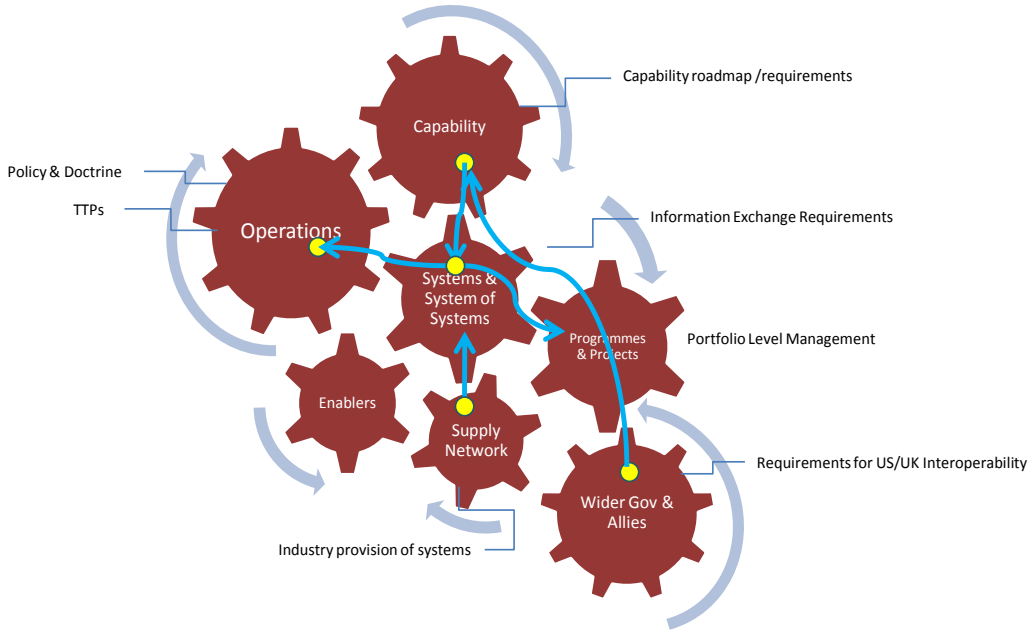


Figure 6. A perspective of the Defence Enterprise consisting of complex interdependencies and asynchronous decision network

Practical utilisation of the framework

Earlier in the paper exercise Talon Strike was used as an exemplar of how experimentation can improve interoperability between allies but also drawing out the challenges of interoperability within a single defence force.

The Talon Strike project explored how information can be most efficiently exchanged between US and UK Forces, each using a myriad of different systems, technologies and procedures. Figure 7 shows the specific simulation and experimentation overlay on top of our generic problem representation.

The key outcome from this activity is a solution architecture that means that as UK and US doctrines evolve, their systems and the way they exchange information remain integrated. This means that project FLOIS / Talon Strike will continue to offer important benefits for future UK-US operations, as well as more immediate lessons for current military activities in Afghanistan.

Each of the identified areas of concern, and indeed their sub-divisions, operate with their own planning cycles for local and historical reasons. This, coupled with the varied planning horizons in each area creates a highly complex asynchronous decision network and one that needs to be understood well if effective change is to be implemented. Coupled with a diverse set of stakeholders with differing priorities and responsibilities this creates, at times, a much greater challenge than, say, the problem of technology integration.

The application of this visualisation is shown in Figure 7, where it can be seen that capability planning involves consideration of the lessons identified from current operations, the system of systems and current challenges, existing and planned programmes and projects, and an understanding of the impact of capability plans. Taking an enterprise view of the problem ensures that no problem is considered in a vacuum and that all stakeholders are considered in the transition to problem resolution.

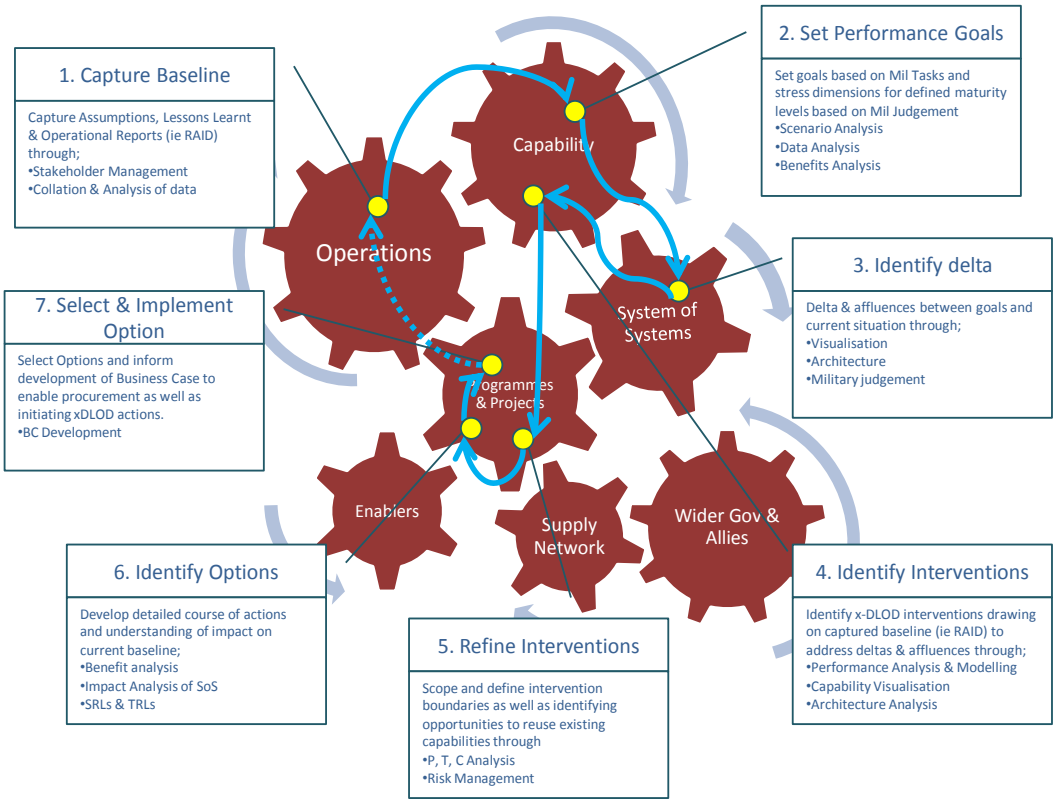


Figure 7. Application of the perspective across capability planning

Developing an Architectural Approach

Niteworks' concept of a common architectural model follows the principles of the MOD System of Systems Approach [21].

Figure 8. Central Focus on Architecture

The Niteworks Acquisition Methods and Tools assessment project builds on a range of projects undertaken by Niteworks to inform the means of achieving an efficient and consistent framework for capability management, including the assessment of risks, opportunities and the impact of potential options. The project has taken full advantage of the breadth of Niteworks projects delivered in the last year which have helped to evolve the methods employed in the capability trade-space. It has also recognised the methods and tools which are already in place within the MOD and, where applicable, wider Industry.

Methods and tools that are applied are captured within a database to ensure standardisation and commonality of approach and the architectural artefacts and assumptions are captured within a common knowledge base. Figure 8 shows a mapping of the types of problems that MOD typically faces.

Our experience is that while problems may be located in one particular area such as capability, whereby there is no clear capability definition or plan, the repercussions across programmes and projects and even operations is significant. Indeed a clear understanding of the demand (the requirement) is critical to any acquisition planning (the solution).

How Simulation and Experimentation Helps

Simulation and experimentation provide a generic approach to achieving coherence across the different areas of the enterprise. The 'footprint' of a typical experiment will cover most if not all of the different areas of concern, as shown in Figure 9.

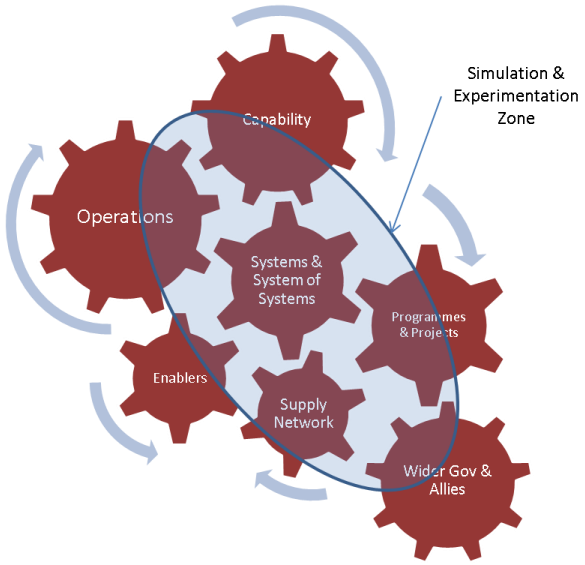


Figure 9. Scope of Application for Simulation & Experimentation

In many respects, well designed simulations or experiments provide the simplest and most cost effective means of addressing the enterprise coherence issues.

By way of illustration, an experiment involving military personnel role playing within a rich environment that captures the behaviour of processes, people and equipment in a realistic scenario offers the potential to undertake development and assessment/testing of a significant breadth of topics, including:

- Operational concepts and military procedures
- Pan-DLOD needs and interdependencies
- Technology maturity and the 'art of the possible'
- Capability goals, requirements and planning
- High level system of systems, and systems architectures
- Programme and project level requirements
- Integration and interoperability solutions

Similarly, there is also the potential to provide training opportunities, as well as system qualification or acceptance.

Emergent Tools and Methods

Although experimentation and simulation can span much of the domain of interest and support enterprise level management and decision making in a wide range of contexts, it tends to provide results at a quality and level of detail that is not needed for all problems. Hence it is most cost effective to deploy a range of methods, tools, techniques and visualisation approaches (which we shorten to methods and tools hereafter) tailored to

specific enterprise activities. This section outlines the contribution made by capability, programme and architecture[9] management tools and sets out their relationship to simulation and experimentation.

Capability Management

A recent Niteworks study has reviewed methods and tools used within UK MOD and elsewhere, in terms of their 'functional' contribution to data management, information management, analysis (gaps and risks), analysis (trading) and visualisation/reporting. The contribution of the tools to the 'capability' cog and its key interconnects (operations and programmes) has also been assessed at relevant granularities.

In total, 112 separate methods and tools were identified and assessed. The assessment showed that none of the methods and tools could cover all of the required space and that there are many overlaps and some gaps. Figure 10 shows the coverage of some of the more widely used methods and tools to illustrate this point.

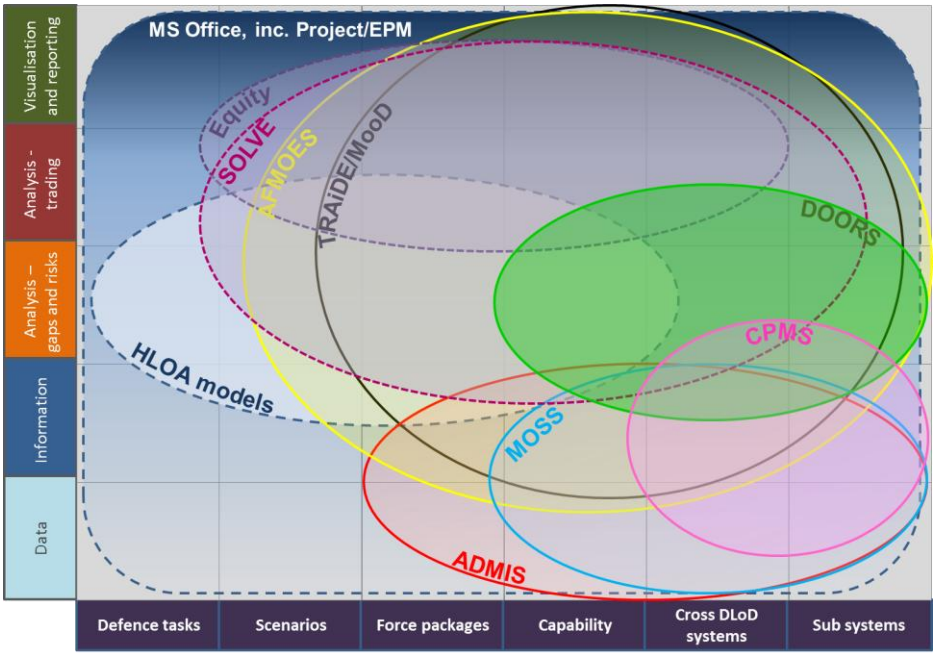


Figure 10. Coverage of widely used Capability Management Tools within MOD

Such methods and tools are critical for effective capability management and are a key enabler to good acquisition. However, due to the evolutionary way in which processes have developed, born out of a historical lack of clear architecture, MOD Capability Areas currently use a disparate set of methods and tools to fulfil their role: the outcome is an undesirably high level of inconsistency. Some capability functions are also inappropriately or inadequately fulfilled through the tools that are available, and in some areas they appear to support only the specific functions in which they have been developed with little wider utility.

There is a need for clear, central direction to drive coherent practices and information consistency across the capability department. The most profound benefit of this would be seen at the Joint Capabilities level where this would create an ability to make evidenced cross-domain, cross-capability decisions and trades. The availability of accurate and timely information – some provided by experimentation and simulation – would remove an over reliance on military judgement and lead to more objective decision making.

Programme Management

In recent years MOD has focussed on developing its approach to Capability Delivery and has implemented several new structures, including Programme Boards (PBs) and Programme Support Functions (PSFs), which aim to provide appropriate levels of coherence across equipment projects and the other DLODs.

Key to programme level management and decision making is the capture, consolidation and dissemination of information from a single authoritative source. This must be underpinned by a set of management information and decision support methods and tools, providing a cross-capability perspective on the programme. This further enables support to decision making activities through electronic assembly, management and

[9] These areas of concern correspond to the equivalent cogs in Figure 7: capability; programmes & projects; and finally systems & system of systems.

dissemination of authorised information to a range of stakeholders. Web access through office IT systems enables stakeholders to get a broader, shared understanding of the programme across multiple perspectives. Availability of an "uncertainty management" capability within the toolset helps to identify possible opportunities for interventions.

Although, as pointed out above, management of coherence across and between programmes depends on good management information, the interactions between programme elements needs to be understood and managed at enterprise and programme architecture level, and continuously through time. This ensures that programmatic decision making is informed by a detailed understanding of the 'flow of consequences', whether the consequences are manifest in the performance, cost or schedule dimensions. A persistent and dynamic architecture model therefore needs to be maintained to support management and decision making; this is discussed in the following section.

Architecture Management

Historically, MOD has invested significant effort in the development of enterprise architectures and architectural frameworks (MODAF) to drive coherency across acquisition projects and across fielded systems. This effort continues today with the SOSA initiative – which draws on a wide range of industry expertise through the Niteworks partnership construct. At the enterprise level, such architectures can underpin the activities of problem capture, analysis and solution specification across all of the key areas of concern. However, understanding, for example, how requirements for military capability are likely to evolve given developments in threats, scenarios and technologies, cannot take place purely at the conceptual level. While the enterprise representations outlined previously can help and can ensure adequate coverage of both the problem and solution spaces, an agile enterprise needs a 'persistent' test bed that provides representative elements such as networks, bearers, applications, procedures and human intervention. These systems and system of systems can be captured using an architectural framework like MODAF [12] – and increasingly with the focus on services and service taxonomies, will be expressed as business, technical and enabling services managed by or provided to the MOD enterprise.

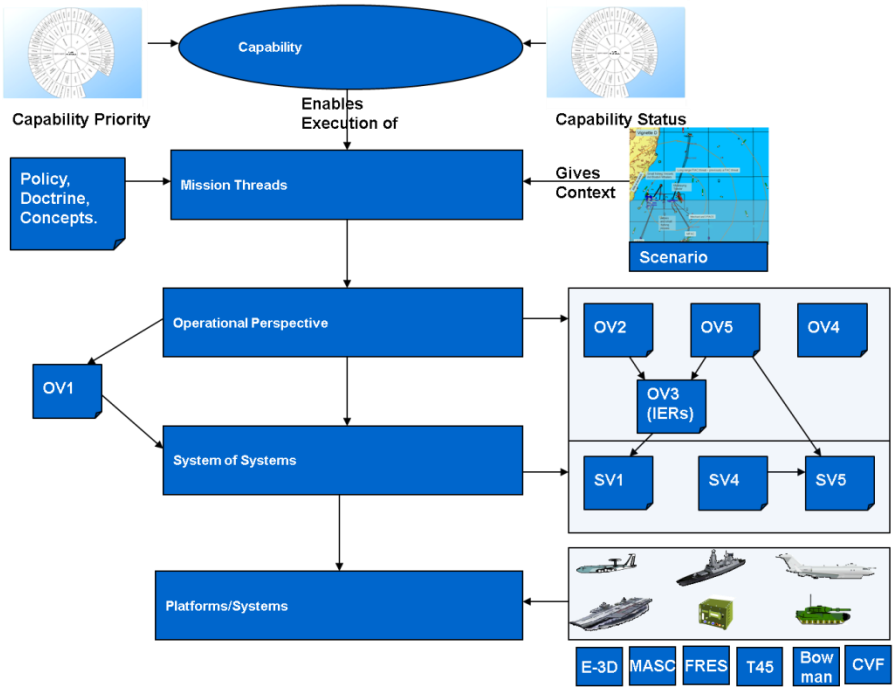


Figure 11. Architectural Support Requirements for Warfighter Experiments

Having a test bed underpinned by common and agreed architectural representation, particularly if service-based, enables the modelling of the baseline architecture and potential solution architectures, as well as supporting what-if analyses to underpin capability and programme level decision making. This approach combines architectural models with a persistent test-bed, enabling all aspects of the systems engineering 'V model' (think and design top down, test and validate bottom up) to be considered across all aspects of the enterprise.

From a practical standpoint, enterprise architecture methods and tools are used typically within a simulation or experiment to:

- Model the baseline and experimental architecture, with warfighter behaviour;
- Model platform and system of systems capability, including Information Exchange Requirements;
- Develop interoperability/integration techniques and solutions.

An illustration of the use of architectural models in support of a warfighter experiment undertaken in Niteworks is shown in Figure 11. The figure shows the linkages between capability, programme and architecture areas of concern.

Summary & Conclusions

It is the intention for Niteworks to build on the range of projects undertaken to inform the means of achieving an efficient and consistent approach to capability management, including the assessment of risks, opportunities and the impact of potential options. The breadth of Niteworks projects delivered in the last year has helped to evolve the methods employed in the capability trade-space (e.g. AEDP, Talon Strike etc). It has also recognised the methods and tools which are already in place within the MOD and, where applicable, wider Industry.

Although the selection of case studies adopted are diverse, the common themes that apply across all situations are clear: the need for collaboration, management of complexity, and a pan-DLOD approach, with the overarching application of an architectural information environment to support identification and analysis of options trading. A case has been made for extensive and continuing application of such an environment to support the capability portfolio through-life.

The role of Niteworks as a MOD-Industry collaboration has been critical to achieving the degree of collaboration needed, and the trading approach has enabled Niteworks to provide significant benefit, even against a challenging legacy and a limiting economic climate.

These principles apply irrespective of whether a problem domain is intercepted at an early or late stage in the acquisition approach, or during its operational deployment. Significantly, the approach has also been demonstrated to apply not only within the C4ISTAR domain, but also more widely, including the introduction of improvements to the acquisition process itself. Delivering longer term benefits by improving the underlying processes has been a key emergent property and taking this forward now forms a core part of Niteworks strategic goals.

References

[1] UK House of Commons Defence Committee, *The contribution of Unmanned Aerial Vehicles to ISTAR capability*, Thirteenth Report of Session 2007–08 , TSO - The Stationary Office (August 2008)

[2] Gray B, *Review of Acquisition for the Secretary of State for Defence*, Independent Report - http://www.aof.mod.uk/aofcontent/downloads/gray/gray_report.pdf , October 2009

[3] UK MOD, *The Defence Strategy for Acquisition Reform*, TSO - The Stationary Office (Feb 2010)

[4] HM Government, *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*, TSO - The Stationary Office (Oct 2010)

[5] UK National Audit Office, *MOD: Major Projects Report for 2009*, Report by the Comptroller and Auditor General, (December 2009)

[6] UK National Audit Office, *MOD: Major Projects Report for 2009: Appendices and Project Summary Sheets*, Report by the Comptroller and Auditor General, (December 2009)

[7] UK MOD, *A Year of Niteworks 2010/11*, HMSO (2011)

[8] UK MOD, *The scope of capability management,* MOD Acquisition Operating Framework, http://www.aof.mod.uk/aofcontent/operational/business/capabilitymanagement/capabilitymanagement_scope.htm

[9] UK MOD, *Equipment, Support, and Technology for UK Defence and Security: A Consultation Paper*, TSO - The Stationary Office (Dec 2010)

[10] UK MOD, The *Enterprise Architecture Strategy: A subset of the MOD Information Strategy*, Ministry of Defence UK (Jul 2010)

[11] UK MOD, *Joint Service Publication 329: Information Coherence for Defence*, Ministry of Defence UK, Issue 3.0 Version 1.3 - Final (01 September 2010)

[12] UK MOD, *MODAF 1.2 - Ministry of Defence Architecture Framework*, http://www.mod.uk/DefenceInternet/AboutDefence/WhatWeDo/InformationManagement/MODAF/

[13] Salamander Organization, *MooD Product Overview*, http://www.tsorg.com/Salamander_PDFs/MooD%20Product%20Overview%201.0.pdf

[14] Barton R J, Whittington R P, *Embracing and working the Lines of Development – Trades and options for effective delivery of military capability through-life*, Command & Control Research Program - 14th ICCRTS (Washington, June 2009)

[15] Barton R J, Whittington R P, *Informing high level trades - some novel techniques*, Command & Control Research Program - 13th ICCRTS (Seattle, June 2008)

[16] Symes G, Daw A J, *On the use of Information Management in the context of Through Life Capability Management (TLCM),* Journal of Naval Engineering Vol 45(2), December 2009

[17] Barton R J, Whittington R P, *TLCM: Working together to enhance military capability*, RUSI Defence Systems Vol 10, No 3, Feb 2008.

[18] UK MOD, *Enabling Acquisition Change: An examination of the Ministry of Defence's ability to undertake Through Life Capability Management*, A report by the Enabling Acquisition Change Team Leader – Tom McKane (June 2006).

[19] UK MOD, *Defence Lines of Development*, MOD Acquisition Operating Framework: http://www.aof.mod.uk/aofcontent/strategic/guide/sg_dlod.htm

[20] Charles Haddon-Cave QC, *THE NIMROD REVIEW: An independent review into the broader issues surrounding the loss of the RAF Nimrod MR2 Aircraft XV230 in Afghanistan in 2006*, TSO - The Stationary Office, (28 Oct 2009) http://www.official-documents.gov.uk/document/hc0809/hc10/1025/1025.pdf

[21] UK MOD, *System of Systems Approach*, MOD Acquisition Operating Framework, http://www.aof.mod.uk/aofcontent/tactical/engineering/content/systems_guidance/se_systemofsystems.htm

NITEWORKS

Meeting capability goals through effective modelling and experimentation of C4ISTAR options

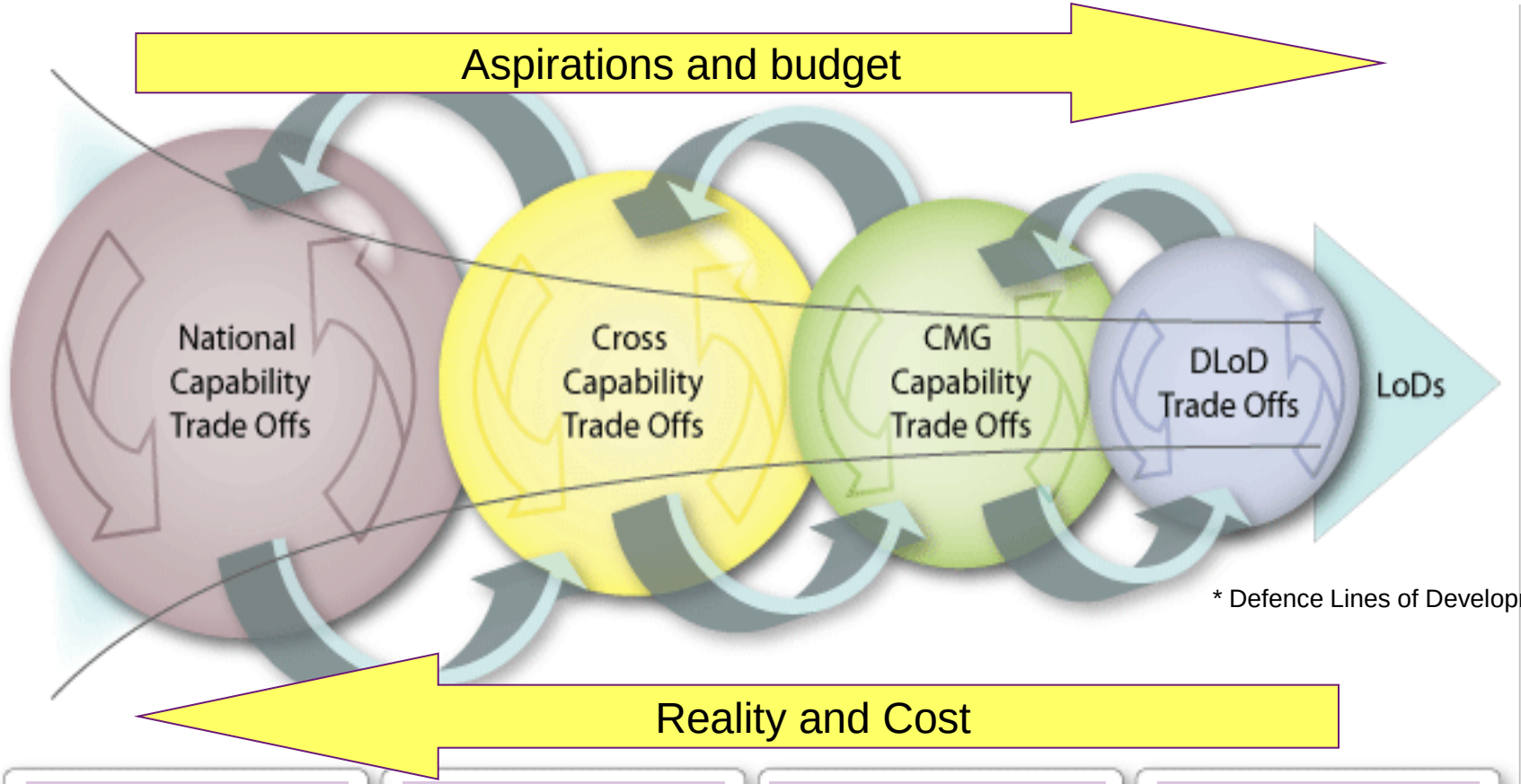
ICCRTS 16, June 2011
Paper 007

Bob Barton, MD Niteworks
Dick Whittington, CSO Salamander

Understanding the problem

NiTEWORKS

Capability and Trade Spaces

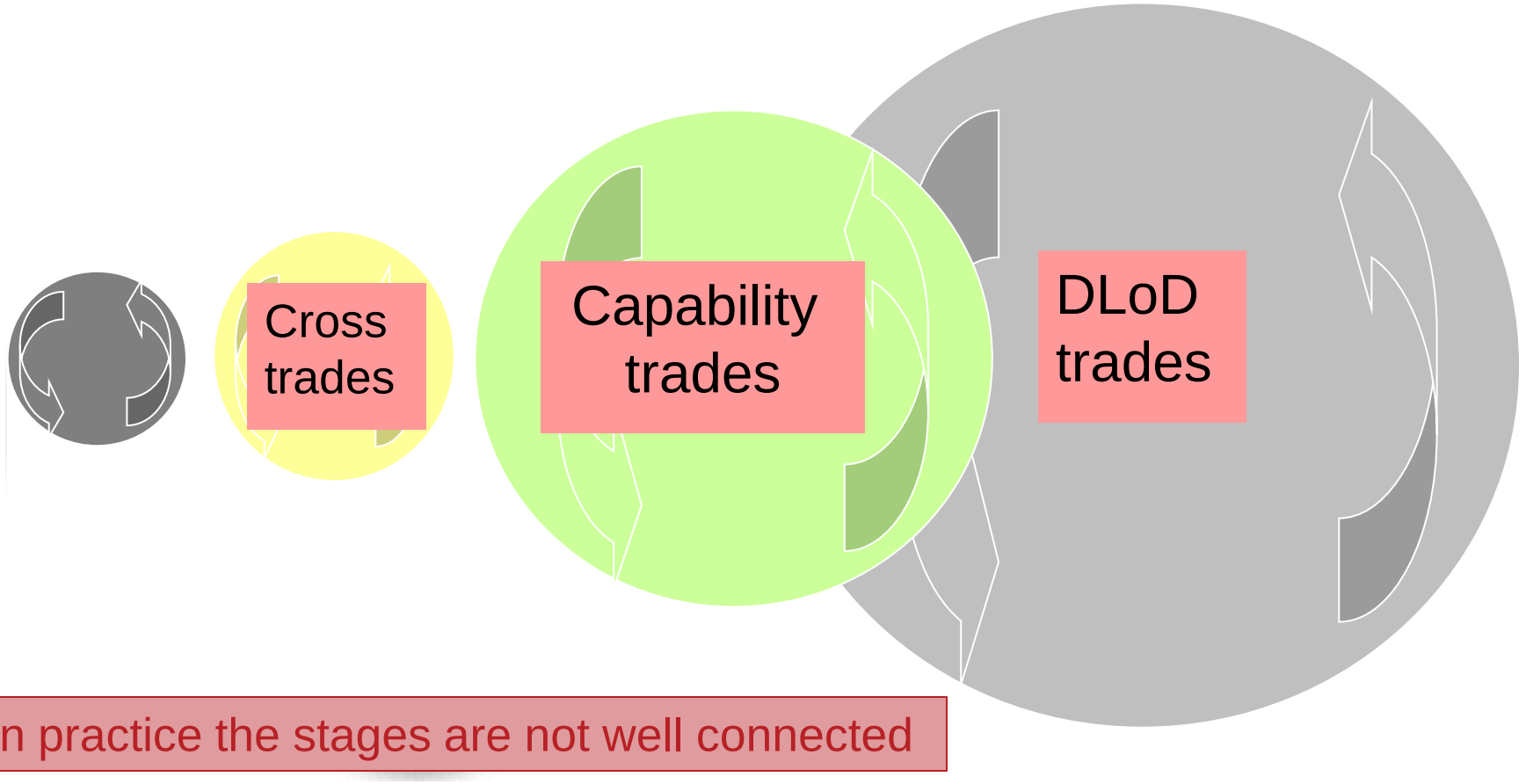


NITEWORKS

Trade Spaces or islands?

Demand

Supply

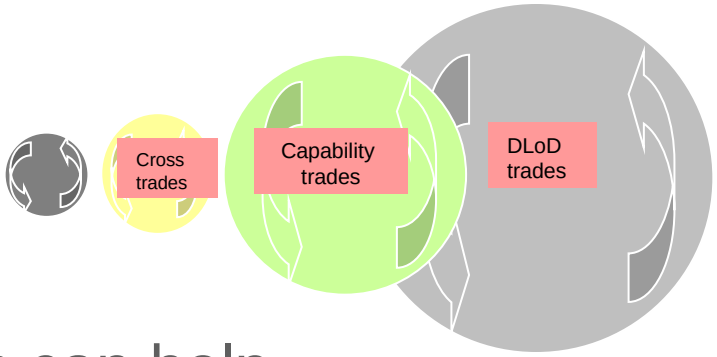


In practice the stages are not well connected

NITEWORKS

What does the model tell us?

- It emphasises the need for effective trades
- It shows how poor ‘left hand’ trades create work to the ‘right’
- Volume of work runs in reverse to size of original circles
  - Logjam
  - Repetition
  - Poor risk understanding
  - Uncontrolled expenditure



- Better collective use of resources can help
  - Consultation and collaboration - NITEWORKS

NITEWORKS

The need for a better approach

- Current acquisition process lacks focus at front end
- 'concepts to capability gap'
- Driving early to competition is not the answer
- Exploring risks and options, safely, will drive success
- 'Value for Money' vs 'Affordability' - subjective/objective?

"...we must rebalance our relationship with industry so that we achieve maximum value for money..."

UK Secretary of State for Defence
22 Feb 2011

Competition vs collaboration?

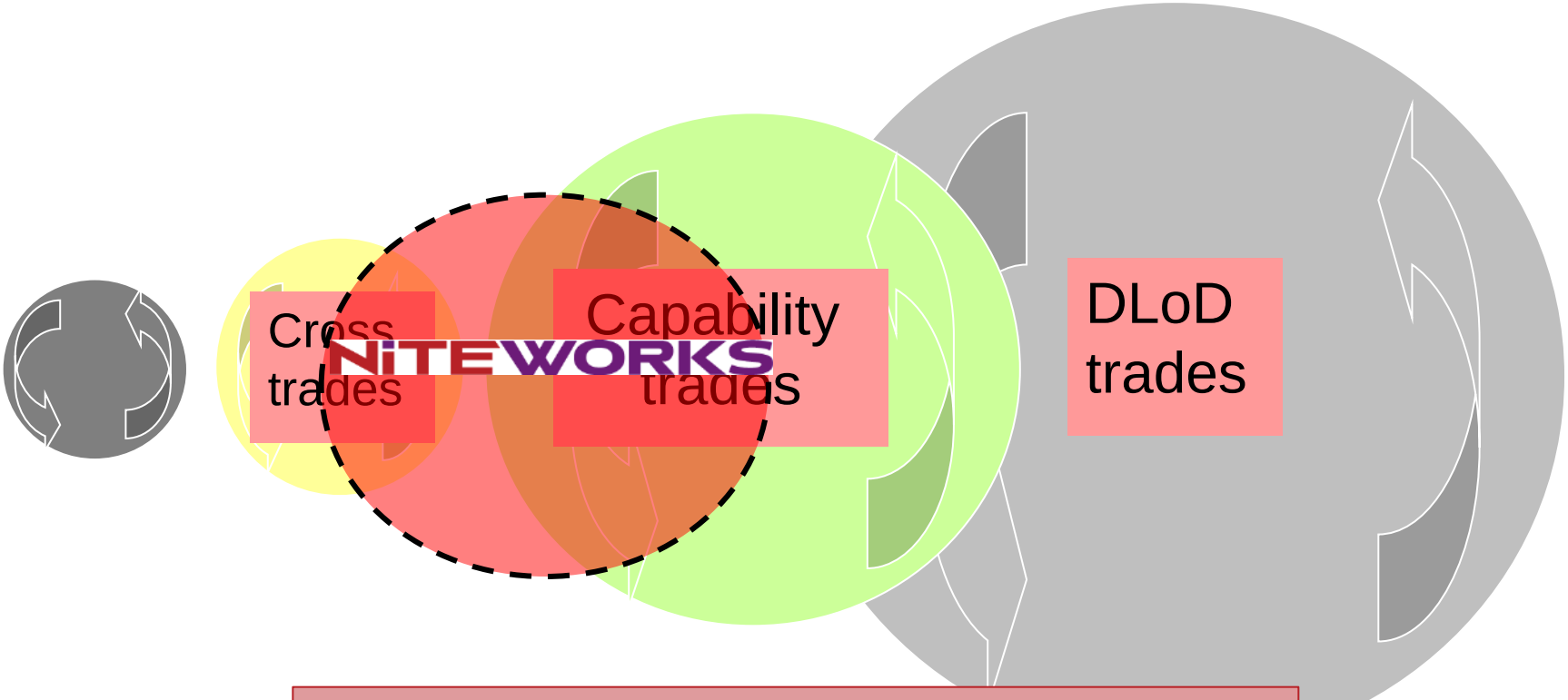
Balance means getting the best of both – Niteworks!

NITEWORKS

Informing the process

Demand

Supply



Niteworks provides an informed link between two key elements of the process

NITEWORKS

Our approach

NITEWORKS

Key **Facts**

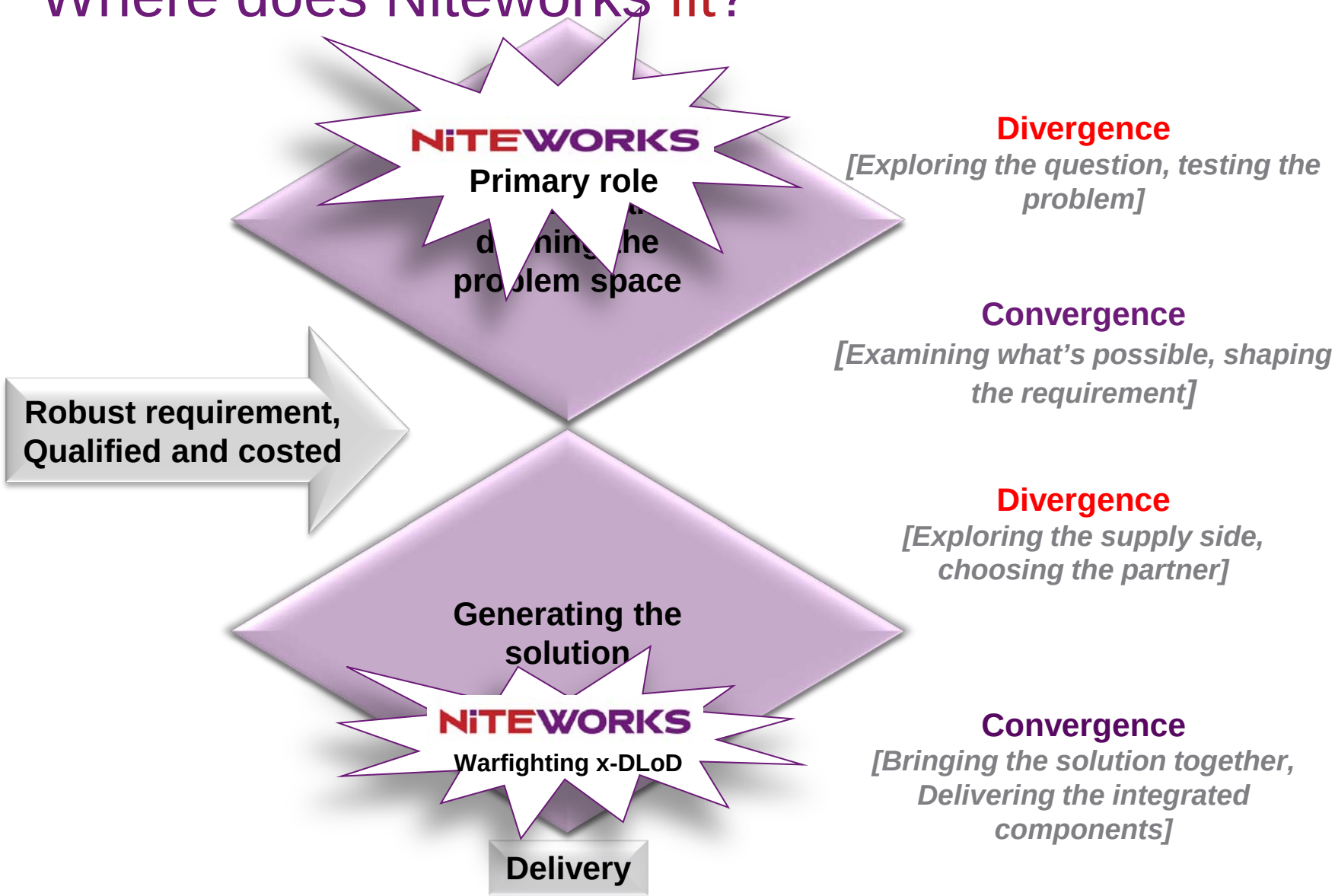
12 industry partners

drawn from the major defence providers

~80 associate members made up of small and medium sized enterprises (SMEs), specialists, academia and consulting companies

NITEWORKS

Where does Niteworks fit?



Divergence
[Exploring the question, testing the problem]

Convergence
[Examining what's possible, shaping the requirement]

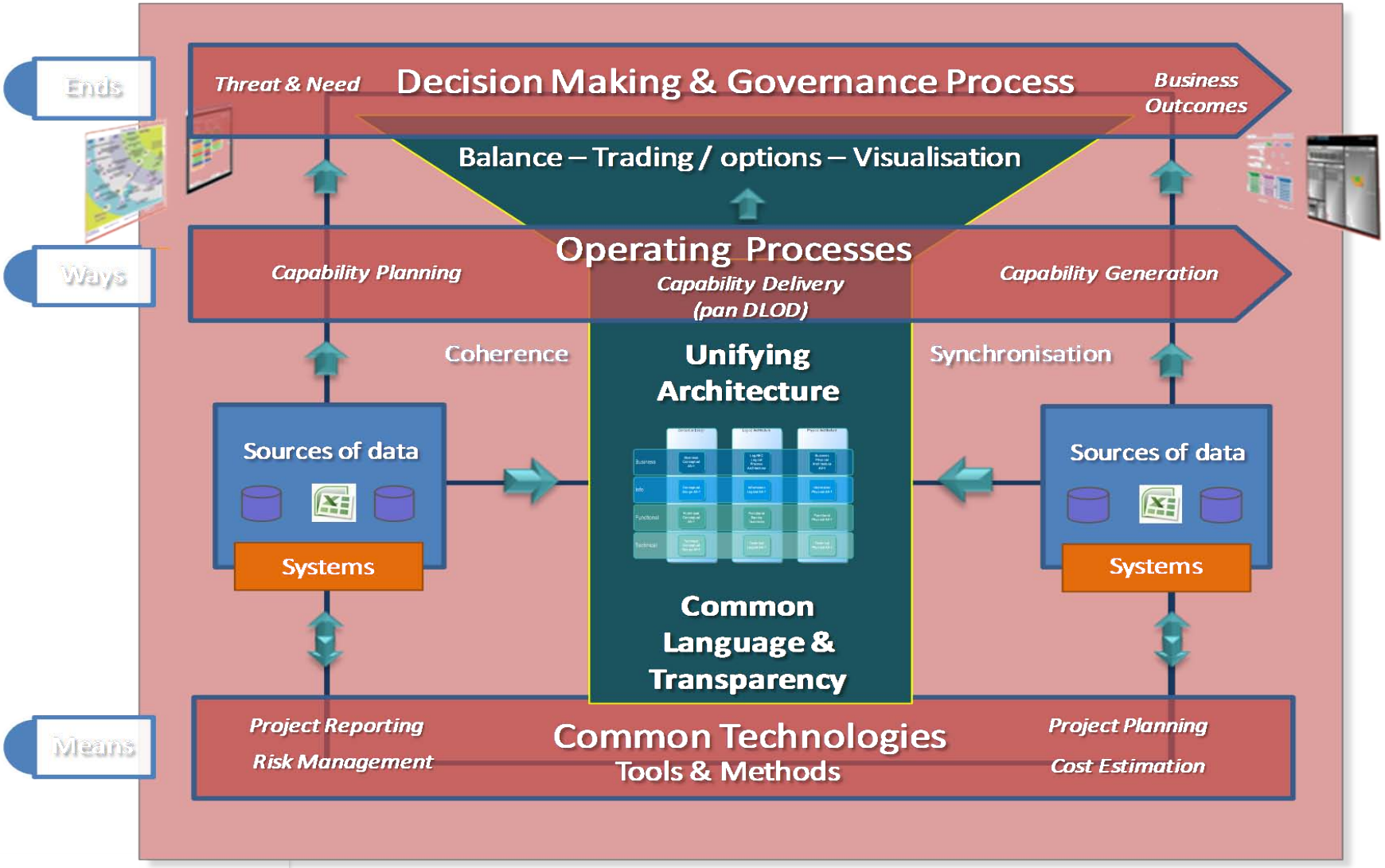
Divergence
[Exploring the supply side, choosing the partner]

Convergence
[Bringing the solution together, Delivering the integrated components]

[Ideally Capability across the DLoDs, through time]

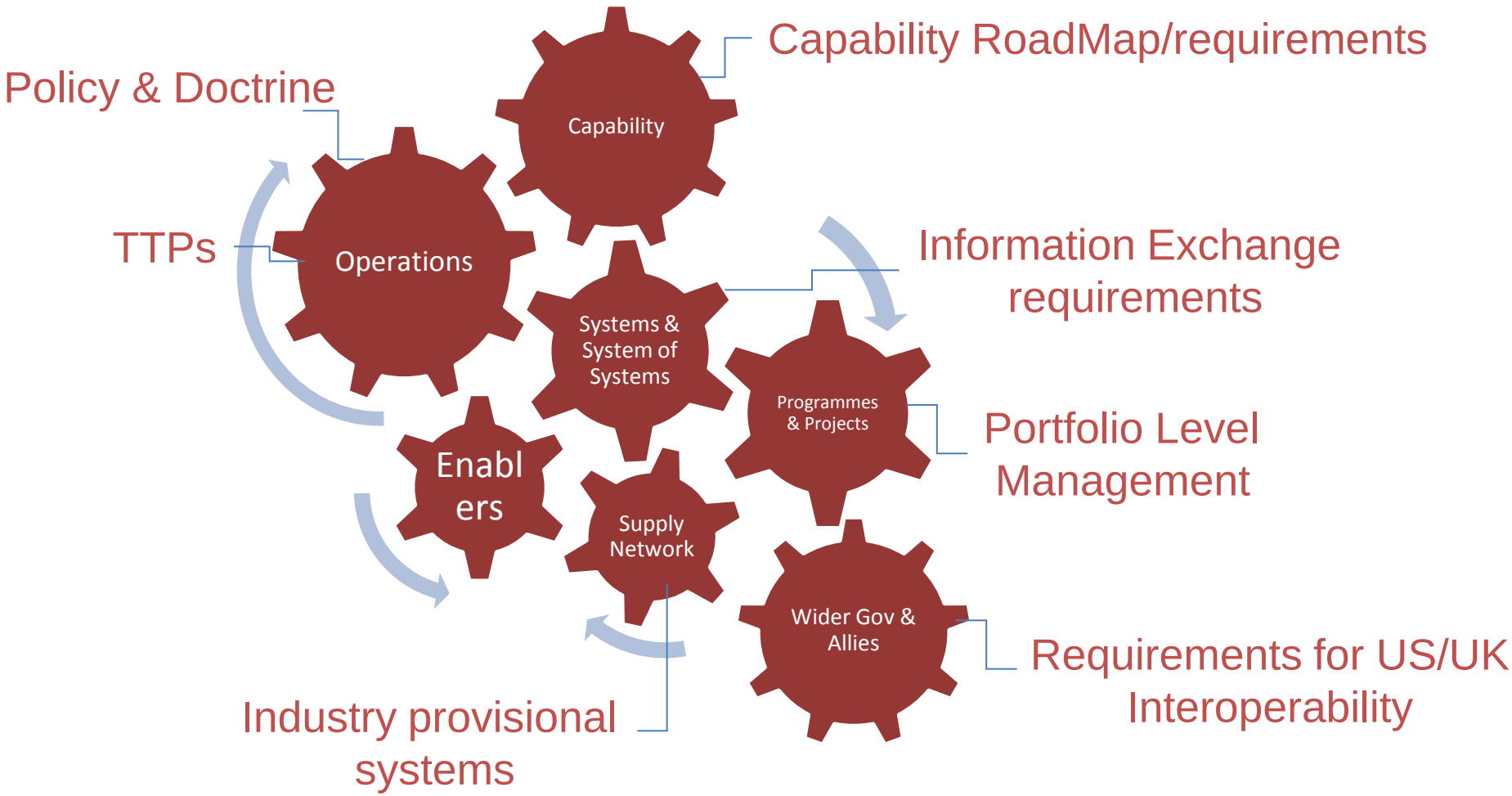
NiTEWORKS

Model-Centric Implementation



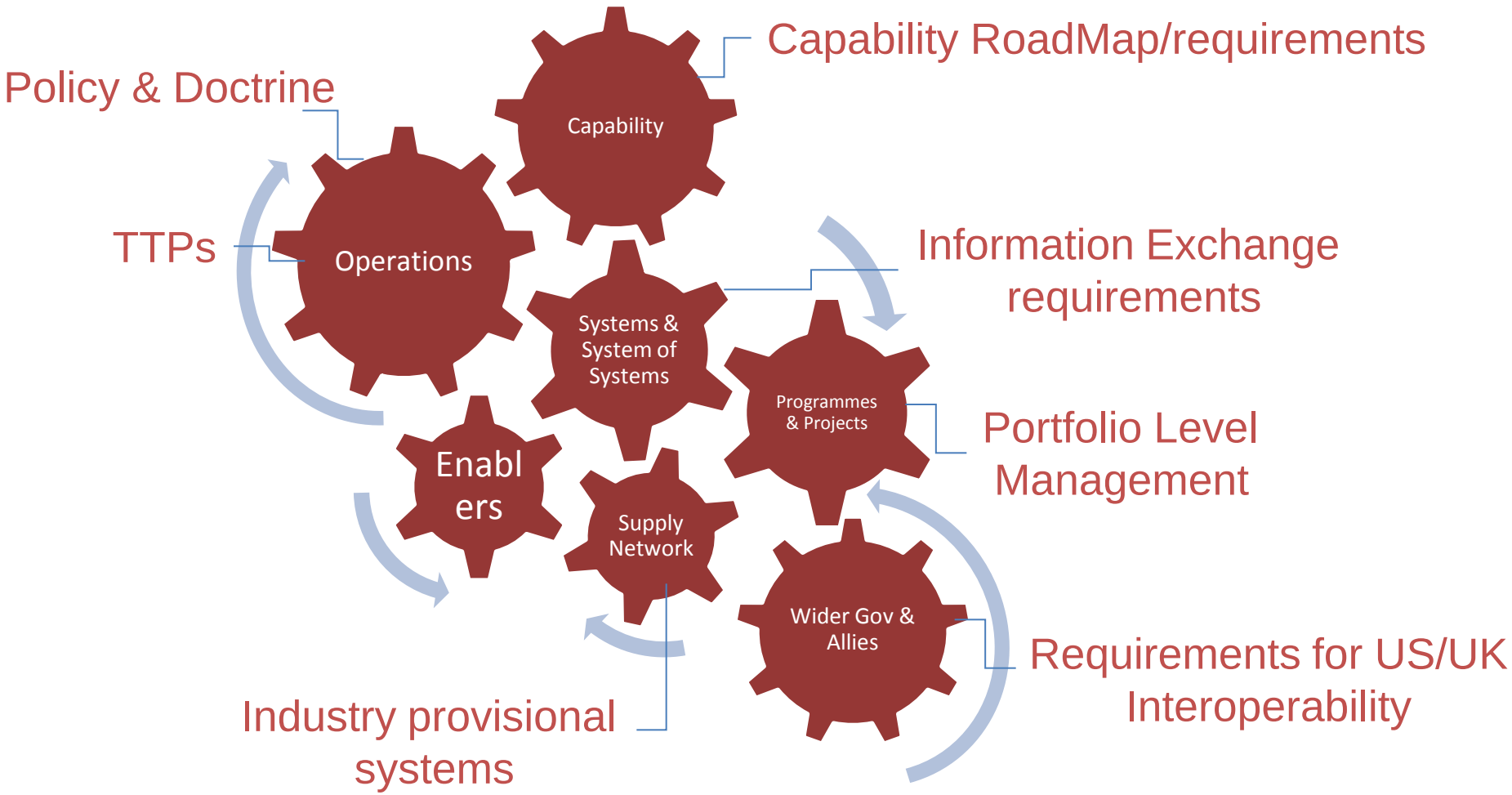
NITEWORKS

The defence enterprise – complex relationships



NITEWORKS

The defence enterprise – complex relationships

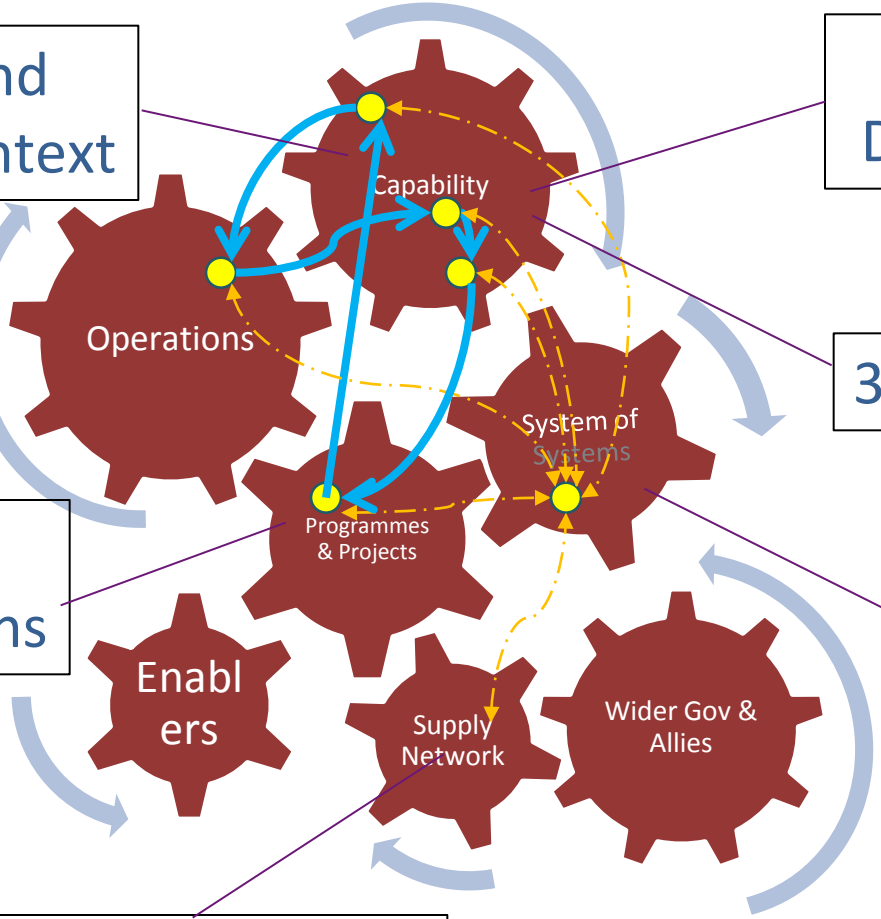


NiTEWORKS

Cross-capability planning

1.Understand Capability Context

2.Understand Demand Changes



3. Analyse Capability

5. Adjust Programme Plans

4. Update Capability Strategy and Plans

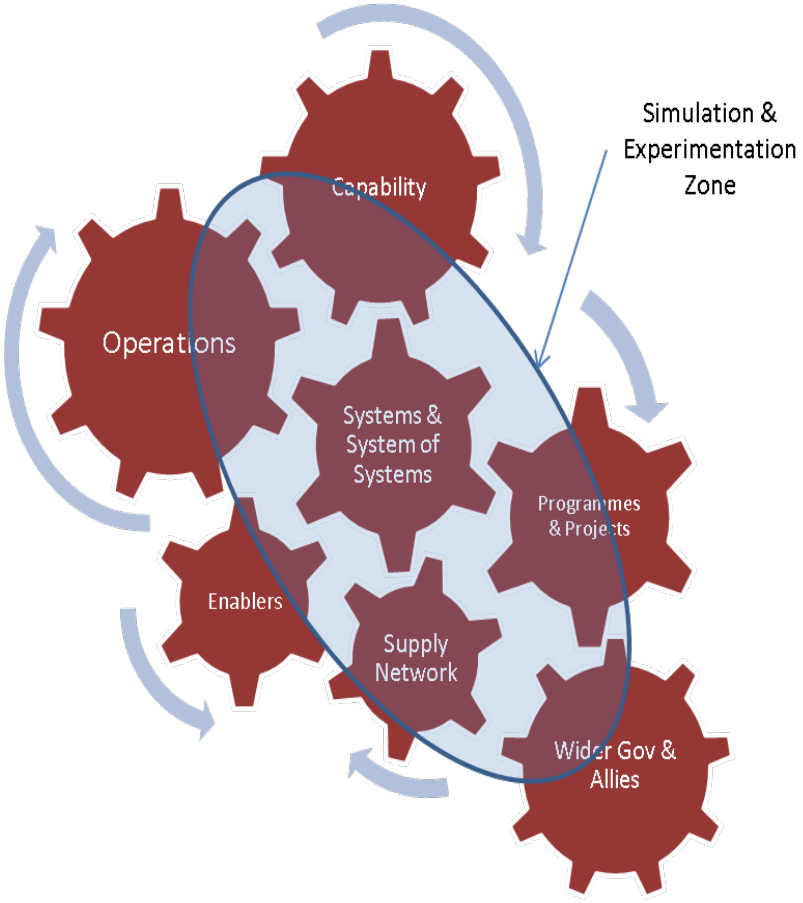
0. Maintain Supply & Demand Baseline

→ Deliberate or unplanned Capability Planning activities

↔ Continuous activities

NITEWORKS

Approach enables a number of aspects to be tested



- ✓**Operational concepts and military procedures**
- ✓**Pan-DLOD needs and interdependencies**
- ✓**Technology maturity and the 'art of the possible'**
- ✓**Capability goals, requirements and planning**
- ✓**High level system of systems, and systems architectures**
- ✓**Programme and project level requirements**
- ✓**Integration and interoperability solutions**

NiTEWORKS

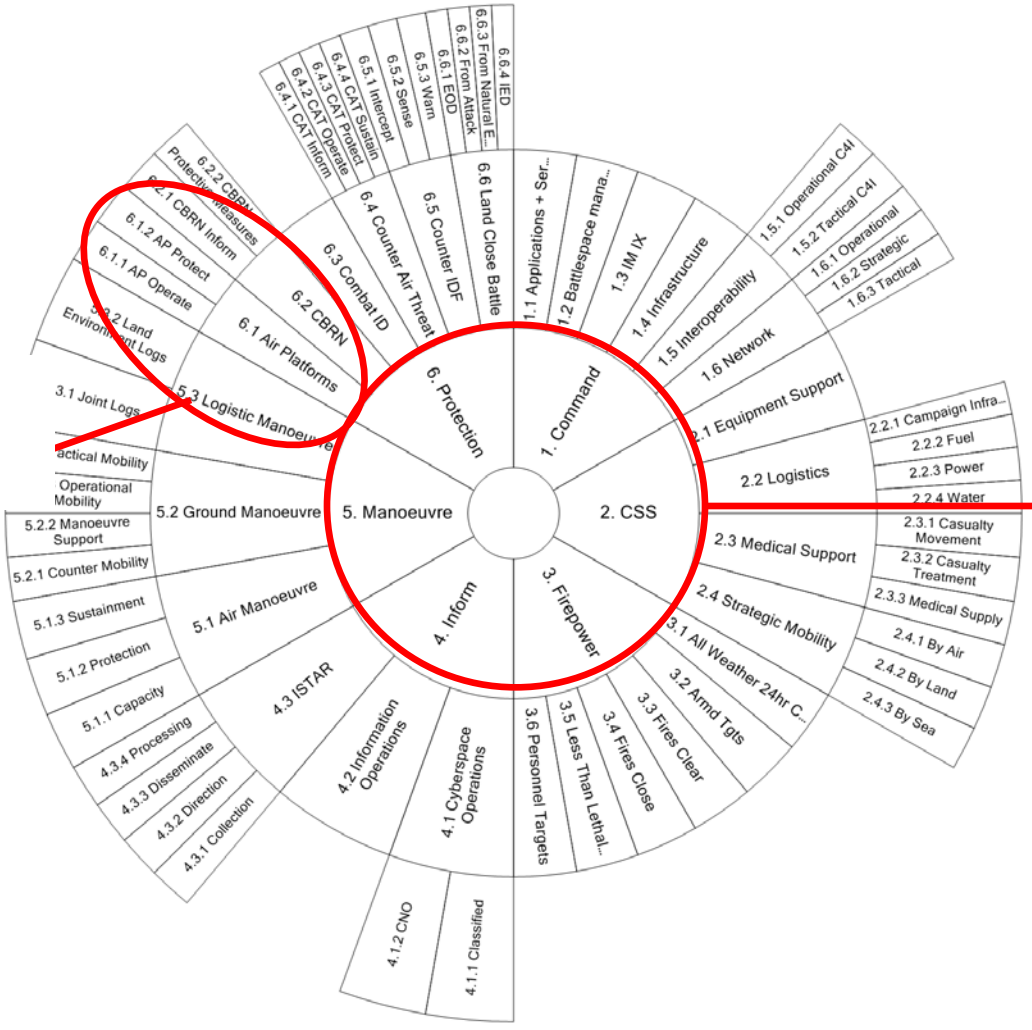
Apply the approach – some case studies

Case study: Army Equipment Development Plan

NB- ALL DATA IS ILLUSTRATIVE

Concept - taxonomy

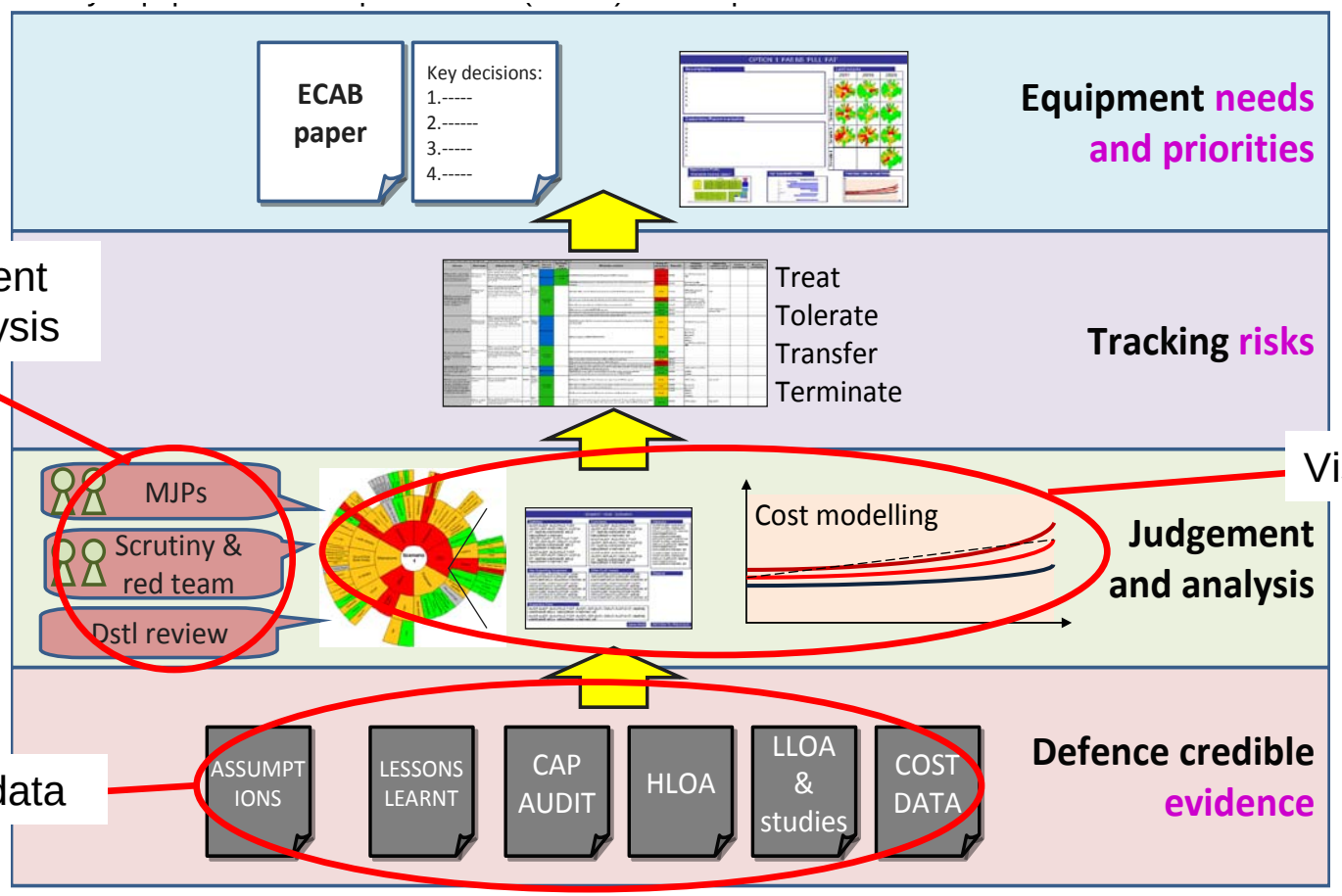
Elements with definitions from doctrine



Tactical Functions

NITEWORKS

Concept - methodology



Summary assessment – Land equipment capability

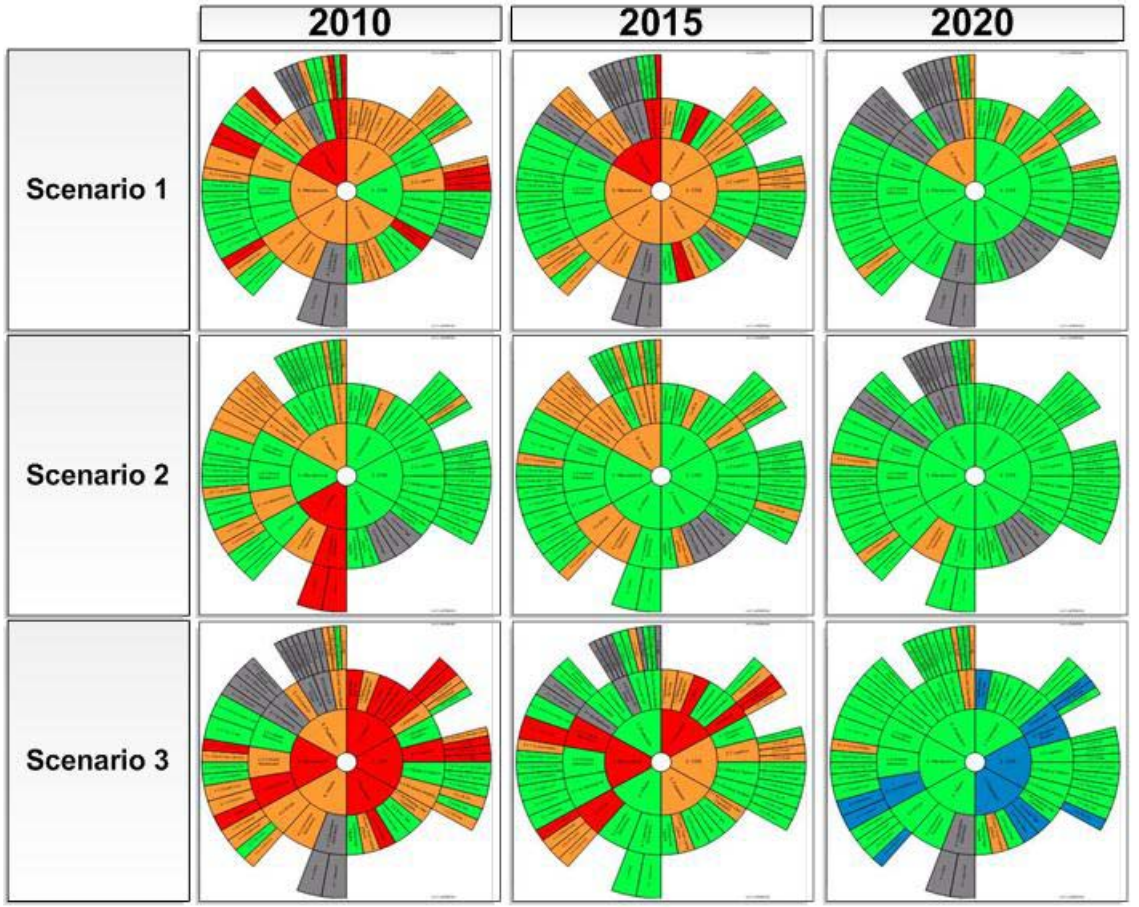
Assumptions

1. Key assumptions which drive the results
2.
3.
4.
5.
6.
7.
8.

Deductions/Recommendations

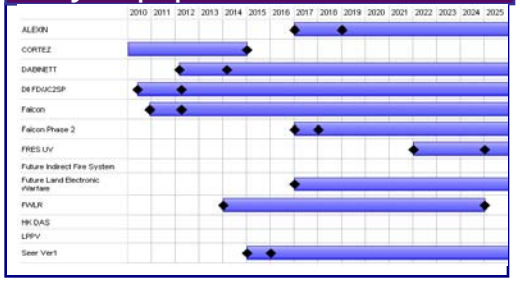
1. The key ‘so what’s which form the basis of decisions taken to rectify the key issues identified
2.
3.
4.
5.
6.
7.

Land outputs

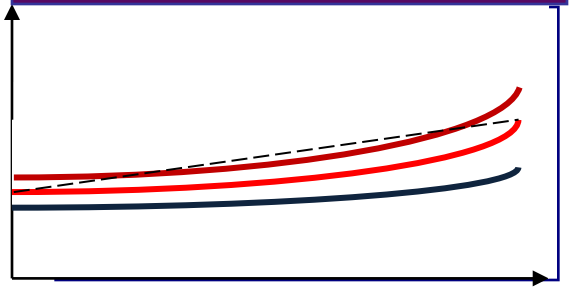


Organisation Profile:

Key Equipment Profile



Predicted Defence Cost Profile



Timeframe 1 Scenario 1

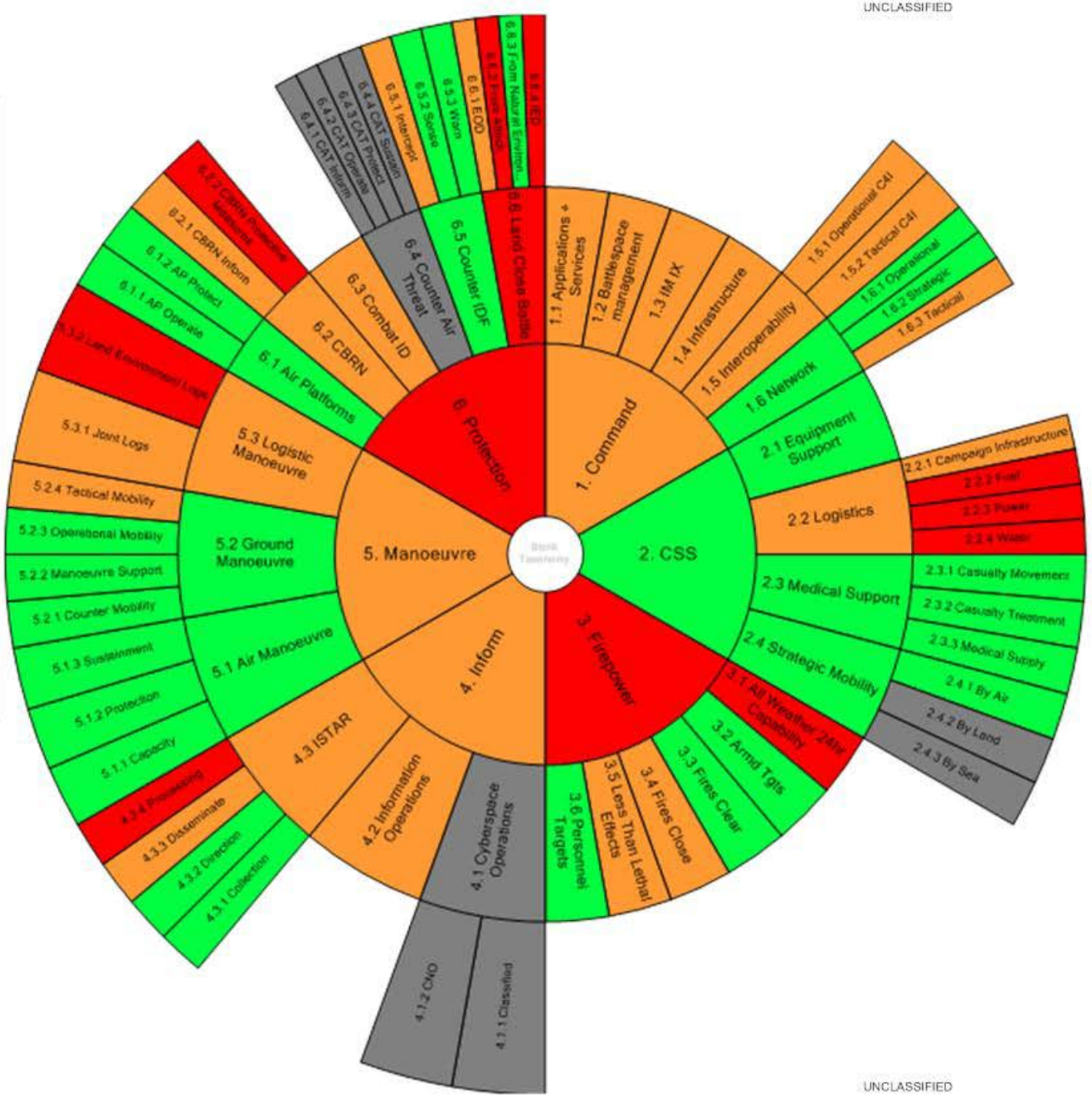
Assumptions and constraints

A number of assumptions and constraints which define this scenario and timeframe. Particularly:
1) The policy environment which defines the requirement.
2) The level of forces in the scenario.
3) The amount and type of equipment that the forces have available.
4)The threat level.
5) Assumptions about concurrency and endurance.

RED	An equipment capability issue/risk impacting Defence ouputs that must be addressed by ECAB/JCB
AMBER	An equipment capability issue/risk impacting Defence ouputs that should be addressed by ECAB/JCB
GREEN	No equipment capability issue/risk impacting Defence outputs
BLUE	An over-supply or overmatch in equipment capability that must be addressed by ECAB/JCB
GREY	Not required in this scenario
WHITE	Classified

TRAiDE

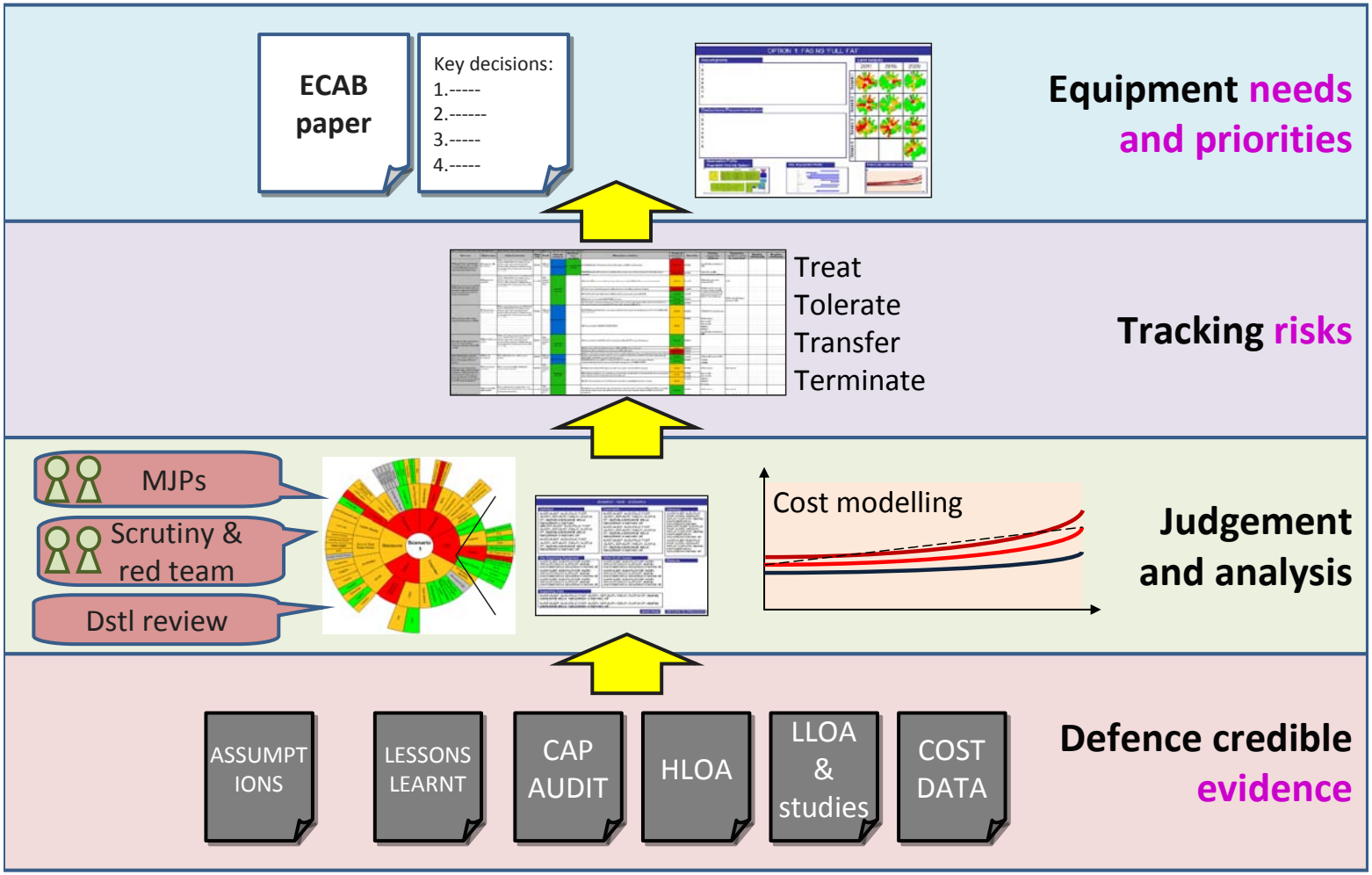
Created: 29/01/2011 18:58:26
Modified: 29/01/2011 21:01:54



UNCLASSIFIED

NiTEWORKS

The Army Equipment Development Plan (AEDP)



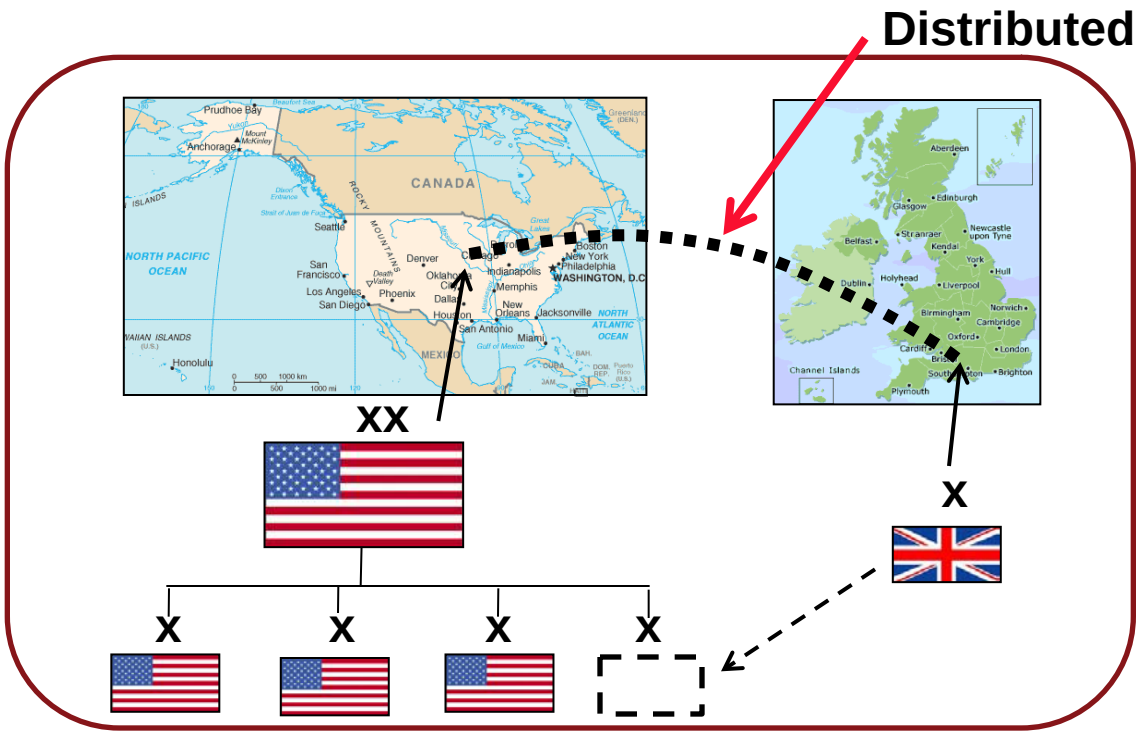
AEDP is a decision support visualisation and information environment based on comprehensive military judgement of Defence validated evidence sources

NITEWORKS

Case study: Talon Strike Multi-National Experiment

NITEWORKS

Talon Strike -the Problem



2011

Experimental Sequence

Ex OF 08 → CWID 09 → Ex OF 09 → Ex TS

Systems- Using UK and US C2 Systems – EP/Overtask Compliant
People - Using UK and US operational Staffs – 10 Mtn Div/12 Bde
Processes - Tackling procedures and processes in digital age

Rapid Spiral Development for CIS Capability Area

NITEWORKS

Benefits of experiment

Provided insights into the issues of track management

Provided British Army with a better understanding of the technical challenges of C2 integration and interoperability

Allowed distributed training to be conducted by exploiting past investment

Provided insights into the utility of specific existing C2 environments

Exposed shortcomings in some theatre applications & other capability gaps for achieving Shared Situational Awareness (Some are now Urgent Operational Requirement actions)

Proved the value of experimentation as an integration tool which should be placed on an enduring basis for National and Multinational experimentation

Proved that coalition interoperability was feasible from both a technical and process view and validated key Information Exchange Requirements

Exposed the complexity of achieving Shared Situational Awareness in a two-nation coalition WAN environment

Helped de-risk future requirements by assessing the use of OneSAF as a core simulation for Divisional level hybrid operations

Exposed the lack of standards for digital symbols and where in existence the disparate ways of interpreting them.

Exposed the need for a Strategic authority on Coalition Network Standards

Confirmed the continued requirement to deploy digitally empowered LOs and the need to improve Information Management & Exploitaiton skills overall.

NITEWORKS

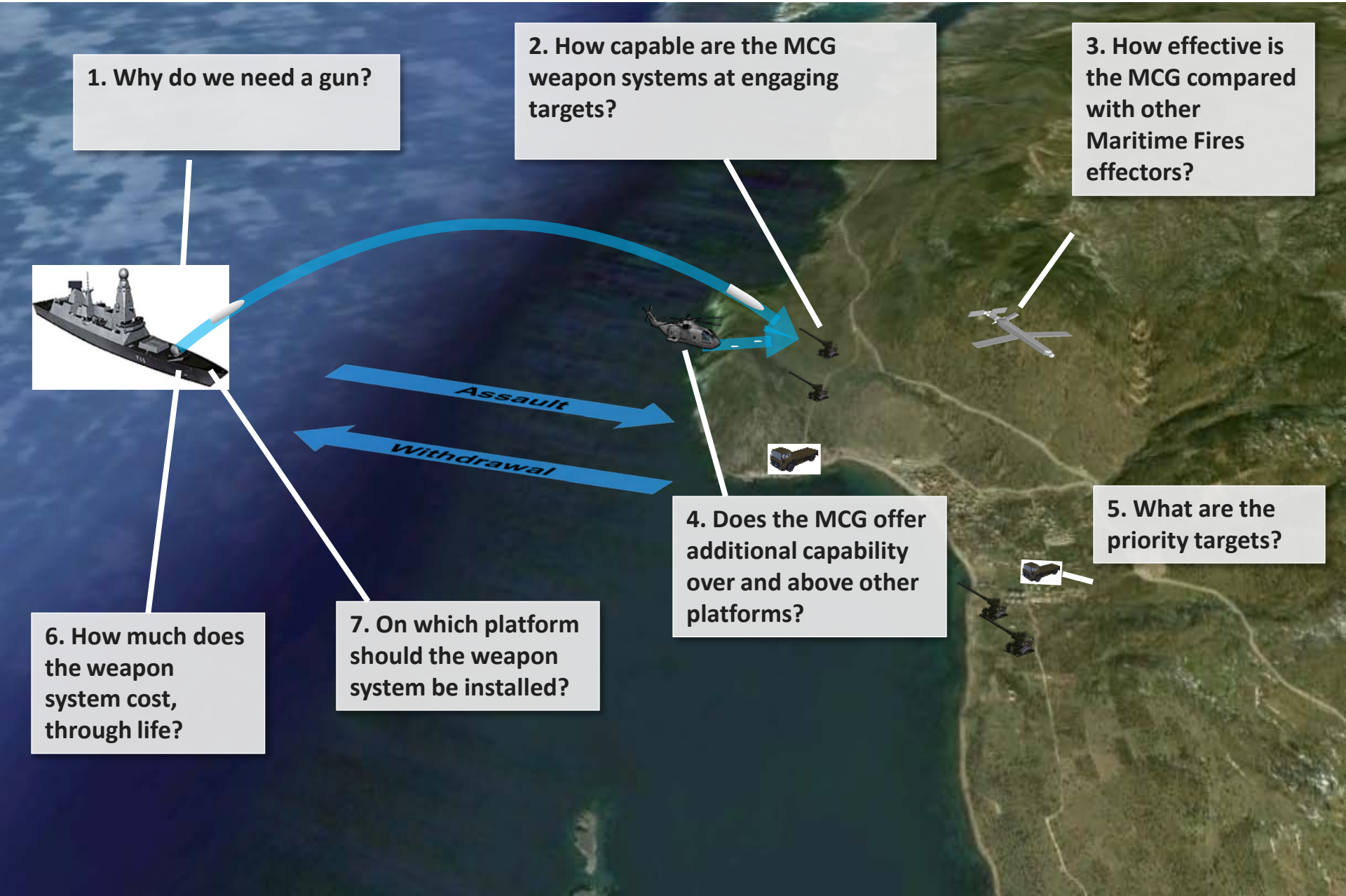
Case study: Future Maritime Fires (FMF)

NITEWORKS

Providing decision support, trade space analysis, for a fires capability

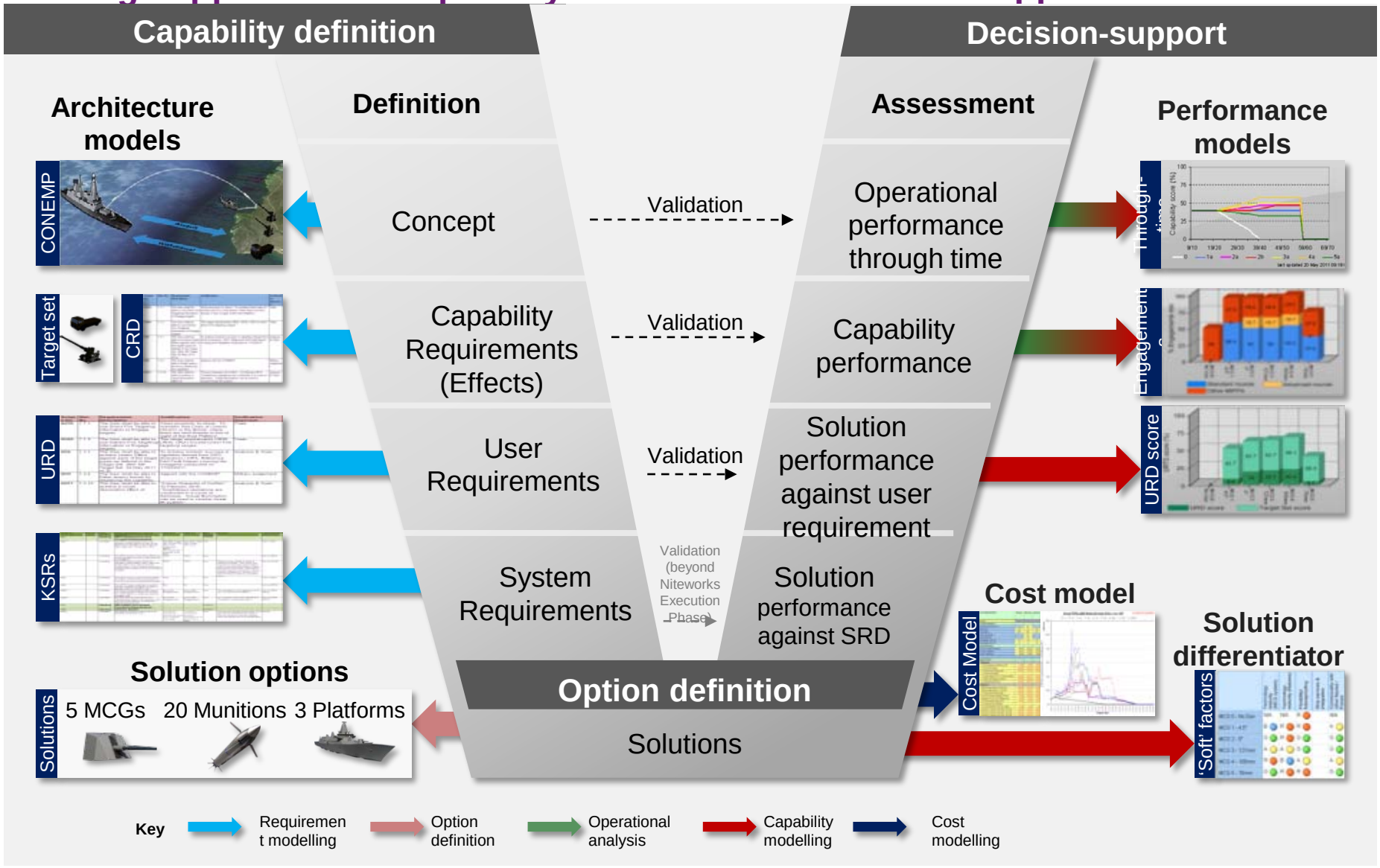
- Future Maritime Fires (FMF) is being delivered by International Guns, Missiles and Rockets (IGMR) Project Team and supported by Niteworks
- Niteworks is modelling requirements, capability & solution effectiveness and cost, enabling trades to be made as part of the acquisition process
- The FMF capability is to “engage and destroy land threats which have the capability to deny own forces the ability to control the Above Water Battlespace in the Littoral”
- The mix is expected to include:
  - **Maritime Indirect Fire System (MIFS):** which is expected to be predominantly met by the MCG
  - **Maritime Indirect Fire Precision Attack (MIFPA):** which is expected to be predominantly met by missiles
- The Concept Phase will determine the appropriate mix of capability to deliver the FMF requirement

Helping the customer answer the key questions about the Maritime Fires capability



NITEWORKS

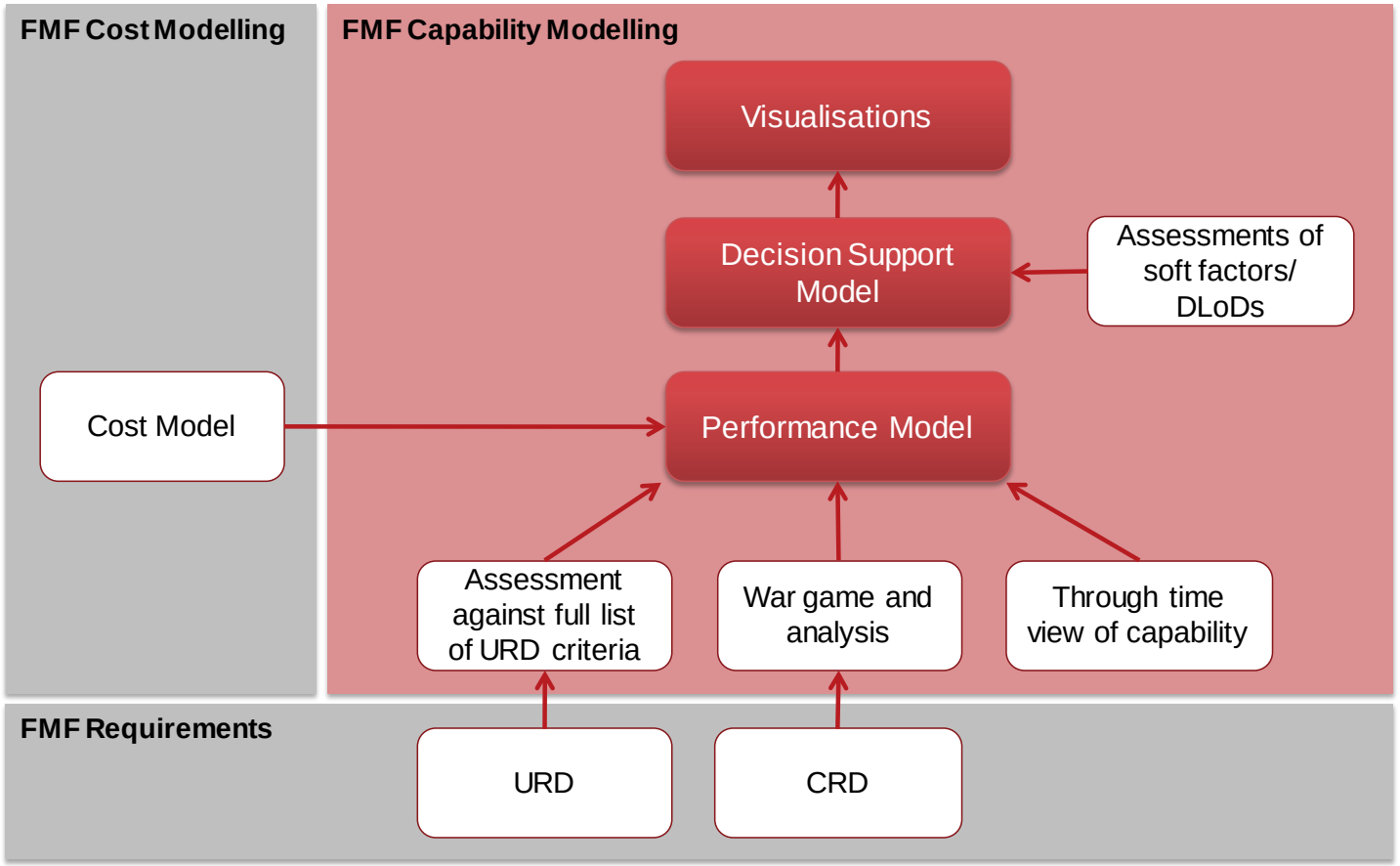
Modelling supports both capability definition and decision support



NITEWORKS

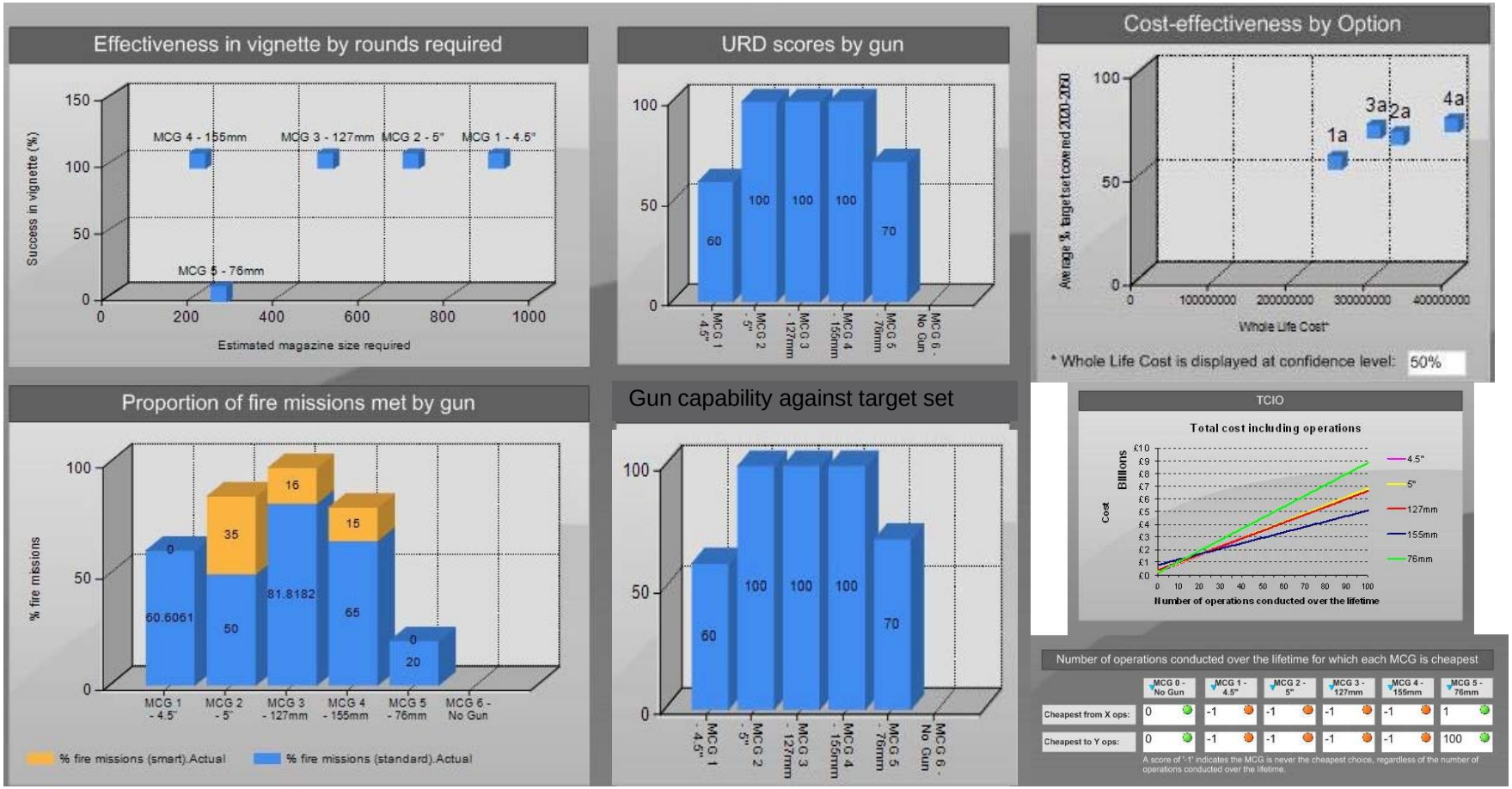
Capability Modelling provides a holistic view of Capability, Cost and Risk

- Flexible model
- Enable trading of Performance, Cost and Time
- Present Outputs as Visualisations as required by the Customer



NITEWORKS

The capability modelling visualisations support decision-making



NITEWORKS

Benefits from FMF analysis

- All stakeholders actively involved before key decisions
- Solid basis of evidence, robust analysis
- A model, refined and tested, for future use
- A model which permits trades between:
  - System of systems and concept of operations
  - Cost and performance
  - OA, Capability and user needs

.....handed over to MOD.....

- Subsequent trades to be performed by MOD staff

NITEWORKS

Summary and Conclusions

NITEWORKS

…..If you want the truth don't expect it to come from a bid

- Getting the requirement right
  - Not exhaustive, but test the "art of possible"
- Being prepared for change
  - Stuff happens – the more you experiment the lower the risk
- Managing Integration begins on day one
  - It's not something you do at the end
- Knowing where your degrees of freedom are
  - And be realistic about using them

Collaboration up front pays dividends

- *It explores the unthinkable, the 'un-thought-about'*
- *Prepares the supply base*
- *Exposes the performance 'knees' which drive cost*

NITEWORKS

Headline benefits being delivered

- Shaping affordable requirements
- Informing Industry-informing MOD where no other mechanism can
- Developing methods which deliver coherence
- Confronting and solving the risks and “difficult issues”
- Providing an alternative to costly and unnecessary competition

Niteworks – the collaborative model

✓A unique capability
✓Constructive challenge
✓Honesty replacing conspiracy

Better decisions, reduced operational risk, lower costs

NiTEWORKS

....and finally.....

"....and there's a trade-off between the gold-plated solution – often admired but rarely competitive even when it does at last hit the market – and what we can get quickly and at better value for money.....

....that's why I'm a supporter of the Niteworks Partnership which helps to improve requirements, reduce risk, and enhance value for money. Niteworks is one of our best kept secrets and deserves to be much better known....."

Peter Luff
UK Defence Minister
February 2011